Bayes' theorem: scientific assessment of experience

Alexander Leonard Benedictus Rutten

Committee for Methods and Validation VHAN, Breda, Netherlands

ABSTRACT

Homeopathy is based on experience and this is a scientific procedure if we follow Bayes' theorem. Unfortunately this is not the case at the moment. Symptoms are added to our materia medica based on absolute occurrence, while Bayes theorem tells us that this should be based on relative occurrence. Bayes theorem can be applied on prospective research, but also on retrospective research and consensus based on a large number of cases. Confirmation bias is an important source of false data in experience based systems like homeopathy. Homeopathic doctors should become more aware of this and longer follow-up of cases could remedy this. The existing system of adding symptoms to our materia medica is obsolete.

Keywords: Homeopathy; Bayes' theorem; Repertory.

Introduction

The Randomised Controlled Trial (RCT) is the best epidemiological instrument to prove that homeopathy is not a placebo effect, but is not a great help to improve the homeopathic method. RCT is not suited to prove that, say, the homeopathic medicine *Natrium muriaticum* (nat-m) cures headache, because nat-m will only cure a small portion of the patients with headache. Nat-m will only cure headache if the medicine 'fits' the patient. This fitting of the patient with the indication involves a remedy picture with a relatively small number of characteristic symptoms or traits and a large number of less characteristic symptoms and traits. The patient that will most likely benefit from the medicine has a combination of several symptoms or traits out of this remedy picture. One of the characteristic symptoms of nat-m is 'recurrent herpes of the lips'. If the patient with headache also has recurrent herpes of the lips, chances that nat-m will cure increase, but not enough to be sure. One of the experiential rules in homeopathy is that you need at least three good symptoms or traits to be sure enough about the choice of your medicine. All this is the conviction of homeopathic doctors all over the world since two centuries. But is it true?

If homeopathy does not work our story about fitting the remedy to the patient is not true. If fitting the remedy to the patient is true this might be an indication that homeopathy works. To prove that a homeopathic medicine should fit the patient we need an accepted scientific model that explains that experience from the past predicts the future. This scientific model exists: Bayes' theorem. But we must realise that a specific experience could be caused by mere chance or based on biased observation.

There are several ways to validate homeopathic knowledge and reduce statistical uncertainty and bias. First we can gather experience from successful cases of different practitioners, as we did using a consensus procedure we called Materia Medica Validation (MMV) [1]. Keeping electronic records of all our prescriptions and patient's symptoms allows retrospective evaluation [2]. The third way is prospective research [3]. Prospective research is regarded as the most valid method, but also has limitations [4].

One of the major problems of homeopathy is a systematic mistake in the materia medica and repertories. As a general rule a symptom or characteristic is entered in the materia medica if it is seen in a patient responding well to a specific medicine, and the medicine is entered in the corresponding repertory-rubric. Therefore, the entries are based on absolute occurrence. Some medicines are used frequently, others seldom. If a medicine is frequently used any symptom will come up eventually in a patient responding well to that medicine, especially if the symptom occurs frequently. Bayes' theorem makes it clear that the entries in the repertory should be based on Likelihood Ratio (LR), representing the relative occurrence of a symptom, instead of absolute occurrence.

Statistical uncertainty

Knowledge based on case reports does have scientific value [5]. Case reports are the basis of many discoveries, but can also be misleading. This can easily be explained by basic statistics. Intuitively we know that it is less probable to throw six, four times in a row with a dice than four times in a row heads with a coin. These are simple chance calculations:

	1 time	2 times in a row	3 times in a row	4 times in a row
Six with a dice	1 in 6	1 in $6 \cdot 6 = 1$ in 36	1 in $6^3 = 1$ in 216	1 in $6^4 = 1$ in 1296
Heads with a coin	1 in 2	1 in $2 \cdot 2 = 1$ in 4	1 in $2^3 = 1$ in 8	1 in $2^4 = 1$ in 16

The same calculations can be used to show when experience could be misleading. Suppose that half of the population responding well to medicine X is chilly. Comparing this to the coin-case there is a chance of one in 16 that a doctor has four subsequent cases of chilly patients responding well to medicine X. In the experience of this doctor all patients responding well to medicine X are chilly. So, if the next patient is not chilly this doctor will hesitate to prescribe X. If this doctor happens to be famous and is asked about his experience with medicine X he will say that these patients are chilly, and all his pupils will hesitate to prescribe X to patients that are not chilly. Beware, much of our knowledge about homeopathic medicines is based on a small number of cases! Even famous doctors cannot fight chance.

Now take a rarer symptom that occurs in one in six cases that respond well to medicine X, say depression. The chance that four subsequent patients seen by one doctor will be depressed is one in 1296. We see that the chance that one doctor has a wrong idea about reality becomes less as a symptom is more rare. In other words, we should never rely on a small number of cases to make any statement about frequently occurring symptoms (confirming Hahnemann's statement that common symptoms, both from patients and remedies, should not be taken into consideration for prescription).

Bias

The goal of science is to reduce information that is false because of chance and/or bias (= systematic error). In our example of chilliness the doctor is first misled by chance and then by bias. This bias is called confirmation bias: he does not see warm patients responding well to X because he never prescribes X to warm patients. In this case chance leads to systematic error. Theoretical convictions can also lead to bias. Homeopathic theory says that substances that intoxicate can also cure. Following this theory we expect that 'aggravation from salt' is an indication for *Natrium muriaticum*. If we subsequently hesitate to prescribe Nat-m to patients that are not aggravated by salt we risk confirmation bias. This paper is mostly about statistical uncertainty, but some remarks will be made about confirmation bias.

Bayes' theorem

Reverend Thomas Bayes (1702-1761) based his theorem on the law of conditional probability and it is explicitly or implicitly used to update prior beliefs in a particular hypothesis after observations or experiments [6]. Conditional probability also governs card-playing: we know the contents of a deck of cards and the contents will change every time a card is drawn. Card-playing is a skill based on knowledge and observation.

Conditional probability is also present in medical diagnostic reasoning. For instance, in a healthy young man with cough and without fever, we don't think of pneumonia. If the patient has fever, the chance of having pneumonia increases, the card 'fever' is already on the table. And if he also has lateral chest pain, chance increases still more, and so on.

We see that different pieces of information increase the chance of a particular diagnosis stepwise. The chance of pneumonia before one piece of information (like cough) is called the *prior chance*. After the information 'cough' we obtain the *posterior chance* of pneumonia, which is slightly raised. The posterior chance after 'cough' becomes the prior chance before the next information (fever). If the patient has fever the posterior chance that the coughing patient has pneumonia is again slightly raised.

Homeopathy is also based on knowledge and observation. Homeopathic doctors have noticed that the symptom 'recurrent herpes of the lips' occurs more frequently in patients responding well to Nat-m than in other patients. This is comparable to the knowledge that patients with pneumonia often have fever, more often than patients without pneumonia. So, the prognosis of the patient with 'recurrent herpes of the lips' as well as the diagnosis of the patient with fever are influenced by the fact that these symptoms occur more frequently respectively in patients responding well to Nat-m. or patients with pneumonia. In other words: experience from the is useful for diagnosing and curing new patients.

The addition 'more than in other patients' in our examples of fever and 'recurrent herpes of the lips' is a crucial element in Bayes theorem. This theorem has several expressions, one of them is:

$$\text{Posterior odds} = LR * \text{prior odds}$$

LR = Likelihood Ratio = prevalence in target population / prevalence in remainder of the population, e.g. the prevalence of 'herpes of the lips' in the population responding well to Nat-m divided by the prevalence of 'herpes lips' in the remainder of the population.

Odds = chance / (1-chance); chance = odds / (1+odds). The Likelihood Ratio (LR) is always larger than zero. If $LR > 1$ the posterior odds increases; if $LR < 1$ (> 0) the posterior odds decreases.

In this formula we see that the chance (and odds) that a medicine will work depends on the relative occurrence of the symptom in the population responding well to the medicine compared with the remainder of the population; Herpes lips occurs more frequently in patient responding well to Nat-m; and a larger difference means larger LR.

Bayes theorem can also be used for differential diagnosis. The diagnosis 'common cold' is less probable than pneumonia if fever is present. Likewise, if the patient has forsaken feelings the chance that Kalium carbonicum will work is less than the chance that Pulsatilla will work. The symptom 'forsaken feeling' is seen frequently in patients responding well to Pulsatilla, but relatively seldom in patients responding well to Kalium carbonicum.

For differential diagnosis we use another expression of Bayes' theorem, now written as:

$$P(M_i | S) = \frac{P(S \cap M_i)}{P(S)}$$

For $P(M_i | S)$ we can read: the chance that medicine M_i will work given the symptom S . $P(S \cap M_i)$ is the chance of the combination 'M_i works' and 'S is present', or, e.g. the prevalence of 'Forsaken feeling' in the population responding well to Pulsatilla. $P(S)$ is the total prevalence of the symptom, e.g. the prevalence of the symptom 'Forsaken feeling' in the whole population.

For clarity we will use the first expression of Bayes' formula in the rest of this paper because the Likelihood Ratio (LR) reflects the homeopathic paradigm the best. Our method is fundamentally based on comparison of populations responding well to a specific medicine with the remainder of the population. The use of odds is somewhat awkward because we are used to chance, but odds can be converted to chance and vice versa. The basic idea is: larger LR (= larger difference between medicine population and remainder of the population) means better indication of the symptom for the corresponding medicine.

Our specification of LR is derived from diagnostic research. In diagnostic research we test for a diagnosis with a specific test and compare the outcome with a reference (gold) standard.

This process gives an outcome like table 1.

Table 1: 2x2 contingency table for assessing diagnostic tests

	Illness present	Illness absent	
Test positive	a= True Positives (TP)	b= False Positives (FP)	a+b
Test negative	c= False Negatives (FN)	d= True Negatives (TN)	b+d
	a+c	b+d	a+b+c+d

The method of diagnostic research can also be applied as prognostic research. During a Dutch prospective LR assessment in 10 practices the presence of the symptom 'recurrent herpes of the lips' was checked in every consecutive new patient. After 3 1/2 years 156 successful prescriptions of Nat-m in 4094 patients were recorded, 24 of these patients had recurrent herpes of the lips (table 2).

Table 2: 2x2 contingency table for the symptom 'recurrent herpes lips' regarding Natrium muriaticum.

	Nat-m worked	Remainder of population	
Herpes lips positive	a =24	b=181	205
Herpes lips negative	c= 132	d=3757	3889
	156	3938	4094

According with these data, the prevalence of the symptom "Herpes lips positive" is $= 24/156 = 0.154 = 15.4\%$ in the Nat-m population and $181/3938 = 0.046 = 4.6\%$ in the remainder. So the $LR = (24/156)/(181/3938) = 0.154/0.046 = 3.347$ (95% Confidence Interval 2.256 to 4.966). This means that the symptom 'recurrent herpes of the lips' occurs 3.347 times more frequently in the population responding well to Nat-m than in the remainder of the population.

Bayes formula can be applied repeatedly. After the first positive test the chance that the diagnosis is correct increases. This posterior chance becomes the prior chance for the next test. This process is called sequential updating.

To illustrate how the homeopathic diagnostic process works with our example of 'herpes lips' and Nat-m we need to estimate LRs for two other characteristic symptoms for Nat-m. Suppose that the symptom 'ailments from grief' occurs six times more frequently in the population responding well to Nat-m than in the remainder of the population ($LR=6$), and the symptom 'dwells on disagreeable occurrences' five times ($LR=5$). Now suppose that Nat-m works in 5% of the cases if given at random, then the prior chance that Nat-m will work, without any confirming symptoms, is 5%. With the three symptoms, applying Bayes' formula repeatedly, the chance that Nat-m will work develops as in Table 3.

Table 3: development of certainty of the prescription Natrium muriaticum after three consecutive symptoms

Symptom	Prior chance	LR	Posterior chance
No symptoms	5%		5%
1. recurrent herpes of the lips	5%	3.347	15%
2. dwells on disagreeable occurrences	15%	5	47%
3. ailments from grief	47%	6	84%

The outcome of these calculations is consistent with homeopathic experience that three good symptoms suffice to prescribe a homeopathic medicine with confidence. The total LR of different symptoms can be calculated by multiplying subsequent LRs, in this case $LR_{total} = 3.347 * 5 * 6 = 100.4$. Then:

Prior chance (before the first symptom) = $5\% = 0.05$

Prior odds = $0.05/(1-0.05) = 0.053$

Posterior odds = $100.4 * 0.053 = 5.321$

Posterior chance = $5.321/(1+ 5.321) = 0.841 = 84\%$

This means, before knowing the patient, the probability he will respond to Nat-m is 5%. After obtaining from him this three symptoms, the probability of being a Nat-m case increases to 84%.

In Table 1 symptom 1 is based on scientific evaluation, the rest is based on estimates. If the prior chance and the LRs of the other symptoms would have been based on assessment, we could state that this prescription had a sound scientific ground based on mathematical theory and assessment of daily practice. Now part of the arguments for this prescription is based on estimates of the importance of the symptoms 'ailments from grief' and 'dwells on past disagreeable occurrences'. The scientific validity of these estimates can be increased by consensus, as we will see later.

Bias in the repertory

Bayes' theorem explains why we should not base our materia medica and repertory on the absolute occurrence of symptoms in patients responding well to a particular medicine. The Dutch LR assessment also investigated the symptom 'fear of death' [3]. Three out of 156 patients responding well to Nat-m had fear of death. In the existing system of the repertory this is reason enough to enter Nat-m in the repertory-rubric 'Fear of death', despite the fact that only 1.9% of the Nat-m patients had this symptom [7]. And, indeed, the medicine Nat-m is mentioned in the repertory-rubric 'Fear of death', implying that the symptom 'fear of death' is a confirmation for Nat-m. Bayes' theory however shows that the opposite is true.

If $LR < 1.0$, the symptom is a contra-indication for the corresponding medicine! The prevalence of the symptom 'fear of death' in the whole population of 4094 patients was 3.9%. Calculating LR for 'fear of death' in relation to Nat-m renders $LR = 0.49$. If we look at the example above and replace the third symptom ('ailments from grief') by 'fear of death', the chance that Nat-m will work after this symptom decreases from 47% to 30%.

Many homeopathic doctors know intuitively that there is something wrong with the repertory: eventually every medicine will turn up in every rubric and this cannot be right. Statistics and Bayes' theorem explain that this intuition is correct, as shown in figure 1. Every symptom is a chance continuum; the intensity of the symptom varies over the total population that responds well to a specific medicine. Homeopathic doctors know that patients responding well to Arsenicum album are generally chilly, but some are very chilly and some are not at all chilly. Prospective research learned that most patients responding well to Natrium muriaticum have no fear of death. Bayes' theorem tells us that a symptom is an indication for a specific medicine only if the prevalence of the symptom in the population responding well to that medicine is more than the prevalence in the remainder of the population (or more than average, which is nearly the same). Intuitively this is easy to understand.

Figure 1: chance continuum for 'fear of death' for Natrium muriaticum: the symptom is seen in 1.9% of the population responding well to Nat-m, and in 3.9% of the general population.

More than average

The consequence of statistical variation and Bayes' theorem is that we should replace the criterion 'seen in patients responding well to the medicine' by 'seen more than average ...'. LR expresses how much more than average a symptom is seen in a specific population. Larger LRs express stronger indications for a medicine. The Bayesian 'more than average' criterion can be applied in various ways; not only in prospective research, but also in retrospective research and (collected) casuistry.

Casuistry

In conventional medicine casuistry is sometimes the only way to detect rare adverse effects of medicines. Casuistry is more important as symptoms are more rare because the relationship between the symptom and a

specific medicine will less likely depend on chance. Above we showed that we need to pool cases if a symptom is more common. If, say, all five patients responding well to a specific medicine are chilly we have still little certainty that chilliness confirms the choice of this medicine. Our *Materia Medica Validation* of 8 March 2002 showed one out of 10 patients responding well to *Baryta carbonica* (Bar-c) with a desire for sweets [8]. Therefore, desire for sweets is not an indication for Bar-c, despite the entry in the repertory. A desire for sweets in 6 out of 10 Bar-c cases would have been a better indication.

Consensus

During the Dutch *Materia Medica Validation* consensus meetings a group of 10-20 doctors present their best cases concerning a specific medicine. In the meeting concerning Bar-c the single bar-c case with a desire for sweets was reported by one doctor. For this doctor 'desire for sweets' was an indication for bar-c, but he was misguided by chance. We get more statistical certainty by gathering cases of more doctors. In the MMV meeting of 11 November 2005 about *Natrium muriaticum* 19 cases were presented [8]. Out of these cases 11 had 'ailments from grief'. The prevalence of the symptom 'ailments from grief' is therefore 58% in the population responding well to Nat-m, with a 95% Confidence Interval of 36% to 77%. The estimate by the group of the prevalence of this symptom in the remainder of the population was 10%, the resulting estimated LR is about 6 for this symptom regarding Nat-m. We must realise, however, that consensus is a retrospective procedure.

Retrospective research

In retrospective research we cannot be certain that the symptom is checked in every patient, resulting in recall bias. The MMV of Nat-m showed only 2 out of 19 patients with 'dwelling on past disagreeable occurrences'. The consensus of the group was that this prevalence was too low, because the symptom was not checked in every patient. Some doctors had no recollection of the presence or absence of the symptom 'desire for sweets' in their Bar-c patients. The presence of a symptom can only be recorded appropriately in prospective research. Another problem with retrospective analysis in consensus meetings is that only successful cases are reviewed.

Our consensus meetings were based on retrospective hand-search in practice administrations. Retrospective research is more reliable after systematic recording. After recording all repertorisations (or symptoms), prescribed medicines and results regarding prescriptions we can evaluate the relationship between symptoms and successful prescriptions. This can be expressed as LRs of symptoms regarding specific medicines.

As all retrospective research, this procedure gives no guarantee that the prevalence of a symptom is correct, because the presence or absence of a symptom is not always recorded. But it does give a comparative indication of the prevalence of a symptom in various populations for a large number of symptoms.

Prospective research

Prospective research of the relationship between symptoms and results is the best in scientific respect, because the symptoms are checked in every patient. The limitation of this kind of research is the limited number of symptoms that can be assessed.

Prospective research also demonstrates the need for better description of symptoms. When do we conclude that a patient 'dwells on past disagreeable occurrences'? This problem is larger when symptoms are more vague.

Some results of prospective research

In our prospective of six homeopathic symptoms in 10 Dutch homeopathic practices during 3 1/2 years 4094 patients were included and the number of evaluated prescriptions was 4072. We found 48 significant values for LR, regarding six symptoms. According to our results regarding five repertory-rubrics (excluding the symptom 'sensitive to injustice' which is not in the original repertory) 56% of the medicines are unjustly entered in these five repertory-rubrics or missing from it.

In table 4 some results are shown for the symptom 'fear of death' [3]. Some of the medicines that are mentioned in the original repertory have LRs <1.0, indicating that these medicines are actually not indicated if the patient has a fear of death.

Table 4: Assessment of the symptom 'Fear of death'. The number of patients with the symptom 'fear of death' was 158 (3.9% of the total population). 95% Confidence Interval is mentioned when results were (nearly) significant [3].

fear of death	158	LR+	95% CI
prevalence=3.9%			
acon	10,6		4,87 to 22,93
am-c	5,82		1,69 to 19,87
anac	11,1		5,57 to 22,02
arg-n	2,01		
ars	5,95		2,88 to 12,2
calc	1,39		
carc	2,45		0,95 to 6,28
ign	2,38		
kali-p	3,27		
lac-c	6,55		1,95 to 21,88
lach	2,51		0,97 to 6,42
lyc	1,21		
mag-c	2,75		
nat-m	0,49		
nux-v	1,3		
phos	1,37		
puls	0,88		
sep	1,7		
sil	1,58		
sulph	0,29		
verat	8,74		2,78 to 27,27

Confirmation bias

In our Materia Medica Validation cases had a history of progression after the medicine longer than one year. This longer follow-up partly remedies confirmation bias, as shown in our prospective assessment of the symptom 'sensitive to injustice' regarding the medicine Causticum. After one half year all patients responding well to the medicine Causticum had the symptom 'sensitivity to injustice'. The prevalence of this symptom in the Causticum-population gradually declined during two years and was 39% in the end, see Figure 2. Explanation: at first Causticum was not prescribed to patients that were not sensitive to injustice, but later on Causticum was prescribed based on other symptoms. We saw a similar development, but less outspoken, for the combinations 'fear of death' and Aconitum, 'grinding teeth during sleep' and Mercurius, and for 'loquacity' and Lachesis.

Figure 2: development of the prevalence of the symptom 'sensitive to injustice' in the population responding well to Causticum during the course of the prospective assessment

Results of MMV were consistent with the results from our prospective study; 4 out of 10 (40%) of the Causticum population were sensitive to injustice, and 7 out of 16 (44%) of the Lachesis population were loquacious. Probably the selection of patients with long-lasting results was responsible for limitation of confirmation bias. The impact of confirmation bias could be variable. McKenzie states that the impact of confirmation bias might be quite limited, but larger in familiar situations [9]. In our prospective research the indications for confirmation bias were stronger for well-known symptom-medicine combinations.

Discussion

The scientific validity of homeopathy is not as weak as many people think. Bayes' theorem provides a solid mathematical ground for medical practice based on previous practice experience. However, the present criteria for accepting a symptom as an indication for a homeopathic medicine are fundamentally wrong. According to Bayes' theorem these criteria should be based on relative occurrence instead of absolute occurrence.

According to our prospective research of six homeopathic symptoms in 4094 patients more than half of the entries in Kent's corresponding original repertory-rubrics are false. This may cause a serious threat to the effectiveness of homeopathy. With prospective assessment of homeopathic symptoms we could increase the effectiveness of homeopathy, but also provide the method with a valid scientific identity, like existing diagnostic research in conventional medicine.

There are other ways of applying Bayes' theorem apart from prospective research. It can also be applied in retrospective research and in validation of materia medica with successful cases using consensus procedures. Single cases should not be used to constitute the materia medica of respective medicines, they can only be useful to indicate rare symptoms.

An important limitation of assessing practice experience is confirmation bias, we tend to see what we already expected. As shown above a longer follow-up could (partly) remedy this bias. An important consequence of this bias that the research we proposed here cannot and should not be used to prove anything. It can be used to improve homeopathy, provided we realise that we fool ourselves trying to prove our existing opinions by this kind of research. Doctors participating in research or consensus groups should be well aware of the risk of confirmation bias.

Assessment of daily practice is hard to monitor objectively. It is expensive to use impartial observers and it takes much time to apply questionnaires to assess clinical symptoms. The least thing we should do, though, is trying to describe our symptoms more accurately. When is a patient loquacious? How many times a week should a patient grind his teeth during his sleep? The research based on such conventions will still give averages with large variance. It can be shown, and is intuitively understandable, that a symptom present in a stronger degree is a stronger indication for the corresponding medicine, resulting in higher LR.

Despite its limitations bayesian assessment of homeopathic symptoms appears to be feasible and is a necessary development of homeopathy. The existing system based on absolute occurrence of symptoms is obsolete.

Conclusion

The existing system of adding symptoms to our materia medica based on absolute occurrence in provings or successful cases is obsolete because it will lead to many false entries in our repertories. By applying Bayes' theorem we can mend this shortcoming and give homeopathy a scientific identity. Bayes' theorem, in fact comparing the population that responds well to a specific homeopathic medicine with the remainder of the population, should be kept in mind while assessing all available data from different resources.

References

- [1] Stolper CF, Rutten ALB, Lugten RFG, Barthels RJWMM. Materia medica validation and meta-analysis: A post-graduate course combining learning and research. *Homeopathic Links* 2004;17(3):186-188.
- [2] Wassenhoven M van. Towards an evidence-based repertory: clinical evaluation of *Veratrum album*. *Homeopathy* 2004;93:71-77.
- [3] Rutten ALB., Stolper CF, Lugten RF, Barthels RJ. Statistical analysis of six repertory-rubrics after prospective assessment applying Bayes' theorem. *Homeopathy* 2009; 98:26–34.
- [4] Rutten ALB, Stolper CF. Diagnostic test evaluation by patient-outcome study in homeopathy: balancing of feasibility and validity. *J Eval Clin Practice* 2009. in press.
- [5] Vandenbroucke JP. In defense of case reports and case series. *Ann Intern Med.* 2001;134:330-334.
- [6] Bayes T. An Essay Toward Solving a Problem in the Doctrine of Chances. *Philosophical Transactions of the Royal Society of Londo.* 1763;53:370-418.
- [7] Kent JT. Repertory of homeopathic materia medica. New Delhi: B Jain Publisher; 1990.
- [8] Barthels R, Stolper E, Lugten R, Rutten L. *Materia Medica bundel*. VHAN 2002.
- [9] McKenzie C.R. (2006) Increased sensitivity to differentially diagnostic answers using familiar materials: implications for confirmation bias. *Memory & Cognition.* 34(3), 577-88.

Teorema de Bayes: uma avaliação científica da experiência

RESUMO

A Homeopatia é baseada na experiência e isto pode ser um procedimento científico se seguirmos o teorema de Bayes. Infelizmente este não é o caso nos dias de hoje. Sintomas são adicionados na matéria médica com base na ocorrência absoluta, enquanto o teorema de Bayes prediz que isto deveria ser feito com base na ocorrência relativa. O teorema de Bayes pode ser aplicado tanto na

pesquisa prospectiva como na pesquisa retrospectiva aplicada a dados consensuais baseados em um grande número de casos. O bias por confirmação é uma importante fonte de dados falsos em sistemas baseados na experiência, como a Homeopatia. Os homeopatas deveriam ficar mais atentos a esse respeito e o acompanhamento mais longo de casos clínicos poderia ser uma solução para este problema. O atual sistema de adicionamento de sintomas na matéria médica é obsoleto.

Palavras-chave: Homeopatia; Teorema de Bayes; Repertório.

Teorema de bayes: evaluación científica de la experiencia

RESUMEN

La homeopatía está basada en la experiencia y éste es un procedimiento científico cuando seguimos el teorema de Bayes. Lamentablemente, esto no acontece en el presente. Los síntomas son agregados en nuestra materia médica sobre la base de su producción absoluta, mientras que el teorema de Bayes afirma que la base debe ser su producción relativa. El teorema de Bayes puede ser aplicado en investigación prospectiva tanto como en la retrospectiva y en consensos determinados en grandes números de casos. El sesgo de confirmación es una importante fuente de datos falsos en sistemas basados en la experiencia, como es el caso de la homeopatía. Los médicos homeópatas deben conscientizarse de estos hechos; del otro lado, controles más prolongados de los casos clínicos pueden ayudar a solucionar esta situación. El sistema actual para agregar datos en la materia médica homeopática es obsoleto.

Palabras-llave: Homeopatía; Teorema de Bayes; Repertorio.

Licensed to [GIRI](#)

Support: authors declare that this study received no funding.

Conflict of interest: authors declare there is no conflict of interest.

Received: 20 December 2010; Revised: 06 March 2010; Published: 30 September 2010.

Correspondence author: Alexander Leonard Benedictus Rutten, lexrtn@concepts.nl

How to cite this article: ALB Rutten. Bayes' theorem: scientific assessment of experience. *Int J High Dilution Res* [online]. 2010 [cited YYYY Month dd]; 9(32): 104-114. Available from:

<http://www.feg.unesp.br/~ojs/index.php/ijhdr/article/view/370/445>