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Cross-sectional survey : Risk-averse French GPs use more rapid-antigen diagnostic tests in tonsillitis

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RESEARCH ARTICLE

Cross-sectional survey : Risk-averse French GPs use more rapid-antigen diagnostic tests in tonsillitis

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Keywords : antibiotic prescription ; diagnosis ; near-patient testing ; point-of-care test ; risk aversion

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14 references, 2 Tables

Short title: GPs' risk aversion behaviour

ABSTRACT (264 words)

Objectives - We tested the following hypotheses: (i) risk-averse general practitioners (GPs) might use more Rapid Antigen Diagnostic Tests (RADTs) in tonsillitis in order to decrease their diagnostic uncertainty; (ii) and GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

Design, setting and participants - We conducted in 2012 a cross-sectional survey of a nationwide French representative sample of 1136 GPs.

Outcome measures - Multivariate analyses adjusted on the four stratification variables (age, gender, location and volume of activity) were performed in order to identify the risk aversion domains associated with indicators of good or poor practice.

Results – 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last tonsillitis case. 59.5% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis; 29.3% of these tests were positive. Among the GPs who used a RADT, 30.7% prescribed an antibiotic; 98.4% did either prescribe an antibiotic because of a positive RADT result, or did not prescribe an antibiotic in view of a negative result. Among the GPs who did not use a RADT, 50.9% prescribed an antibiotic. In multivariate analyses, risk-averse GPs declared being more aware of and compliant with guidelines (OR=1.50, P<.01), and used RADTs more often in their last patient (OR=1.39, P<.01). Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-seeking doctors (OR=1.21, P<.05).

Conclusions - RADTs for tonsillitis are a powerful tool to decrease diagnostic uncertainty and unnecessary antibiotic prescriptions among GPs.

ARTICLE SUMMARY

Article focus :

- Risk-averse general practitioners (GPs) might use more Rapid Antigen Diagnostic Tests (RADTs) in tonsillitis in order to decrease their diagnostic uncertainty
- GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

Key messages :

- Risk-averse GPs declared being more aware of and compliant with guidelines
- Risk-averse GPs used RADTs more often in their last patient (
- Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-seeking doctors.

Strengths and limitations of this study :

- First study to have assessed the impact of risk-aversion behaviour of physicians on antibiotic prescribing using a standardised measure scale.
- Based on declarative data, and not on real practices, but standardised questions allowed us to assess the true impact of risk aversion and clinical vignettes have been shown to be a valid tool for measuring the quality of physician practice.

INTRODUCTION

Given the current worldwide bacterial resistance crisis, decreasing unnecessary antibiotic use is crucial. In France, 80% of all antibiotics used in humans are prescribed in the outpatient setting, and general practitioners (GPs) account for 71% of these prescriptions.[1]

Tonsillitis is one of the leading causes of antibiotic use in the outpatient setting.[2] Rapid Antigen Diagnostic Tests (RADTs) detecting group A streptococcal infections offer a useful mean to reduce unnecessary antibiotic prescriptions: the 2011 French guidelines recommend using these tests in all cases of tonsillitis in children ≥ 3 years old and prescribing antibiotics only in proven group A streptococcal infections (positive RADT result).[3] If a RADT is not available, the guidelines explicitely state that no antibiotic therapy is needed.[3] However, in France, RADTs are underused for patients presenting with tonsillitis.[4]

Non-compliance with guidelines can be explained by a variety of factors.[5] Several studies suggest that risk aversion may be a driver for unnecessary antibiotic prescriptions and non-compliance with guidelines regarding antibiotic prescriptions. At country level, « uncertainty avoidance » was recently identified in multivariate analysis as one of the national cultural dimensions significantly associated with (inappropriate) use of antibiotics for colds/flu/sore throats,[6] confirming previous findings.[7] At the individual level, recent reviews of qualitative studies identified diagnostic uncertainty as an important factor favouring antibiotic misuse.[8, 9]

In this survey of a nationwide French representative sample of GPs, we wanted to assess the following hypotheses, taking tonsillitis as an example: (i) risk-averse GPs might use more RADTs in order to decrease their diagnostic uncertainty; (ii) and GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

MATERIAL AND METHODS

Sampling

A panel of French GPs was constituted in June 2010. Its procedures have already been described elsewhere.[4] Briefly, 5170 GPs were selected by random sampling from the Ministry of Health's exhaustive database of health professionals in France. Sampling was stratified for location of the general practice (urban, peri-urban, or rural areas), gender, age (<49, 49–56, >56 years old) and the number of consultations (<2849, 2849-5494, >5494) in 2008. Of the 3888 contacted and eligible GPs, 1431 (36.8%) agreed to participate in the panel, i.e. to provide regular data on their activity and respond to 5 consecutive surveys on different topics during a 30-month period. The results presented in this study are based on the 1136 GPs who participated in the fifth national cross-sectional survey, conducted in Novembre 2012 (attrition rate between the first and fifth cross-sectional surveys: 20.6%).

Ethics Statement

The National Data Protection Authority (Commission Nationale Informatique et Libertés), responsible for ethical issues and protection of individual data in France, approved the panel and its procedures.

Procedure and questionnaire

Professional investigators contacted the GPs and interviewed them with computer-assisted telephone interview software, using a standardised questionnaire (supplementary file). It collected information about their professional characteristics, their practices regarding tonsillitis, and their risk aversion attitudes for daily life in general, personal finances and medical behaviour regarding patients' health, using a Likert scale from 0 (not at all inclined to take risks) to 10 (totally inclined to take risks).[10, 11] We considered a scoring below or equal to 5 to be risk-averse.[10, 11] From the questionnaire we studied the following indicators of compliance with tonsillitis guidelines: awareness and use of national tonsillitis guidelines (indicator 1, reflecting good practice); use of a RADT in the last patient aged between 3-16 years presenting a tonsillitis (indicator 2, good practice); among GPs who declared using a RADT, antibiotic prescription in case of a positive RADT result and absence of antibiotic

prescription in case of a negative RADT result (indicator 3, good practice); and among GPs who did not use a RADT, prescription of an antibiotic (indicator 4, reflecting poor practice).

Statistical analysis

Due to the panel participants' characteristics, we weighted the data in order to obtain a representative sample of the national French GP population for age, gender, location and volume of activity. For indicators 1 and 2, multivariate logistic regressions adjusted on the four stratification variables were performed, and for indicators 3 and 4 sample selection models in two steps were used to identify the risk aversion domains associated with indicators of good or poor practice in order to take into account the selection effect of the sample. In the first step, the dependent variable was the use of RADTs; in the second step, the dependent variable was either indicators 3 or 4. The stratification variables were computed in the first step of the model. All analyses were performed using SAS 9.3®.

RESULTS

The socio-demographic characteristics of the participants are presented in Table 1. 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last tonsillitis case (indicator 1). 59.5% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis (indicator 2); 29.3% of these tests were positive and antibiotics were prescribed in 30.7% of the cases when a RADT was used. Among the GPs who used a RADT, 98.4% did either prescribe an antibiotic therapy because of a positive RADT result, or did not prescribe an antibiotic therapy in view of a negative result (indicator 3). Among the GPs who did not use a RADT, 50.9% prescribed an antibiotic (indicator 4).

Risk aversion behaviour

The prevalence of risk-averse GPs for the three following domains was as follows: 42.1% for the daily life scale, 59.3% for the personal finances one and 67.6% for the medical behaviour regarding patients' health scale.

Association between practices and risk aversion behaviour (Table 2)

Risk-averse GPs declared being more aware of and compliant with guidelines, and used RADTs more often in their last patient. Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-seeking doctors.

DISCUSSION

Our two hypotheses were verified: we found that risk-averse GPs were using RADTs more often and that risk-aversion behaviour was associated with an increase in antibiotic prescriptions when RADTs were not used. Since the literature suggests that risk aversion may be a driver for unnecessary antibiotic prescriptions, the leverage effect of RADTs appears to be all the more powerful since GPs are risk-averse. It seems that the diagnostic uncertainty leading to unnecessary antibiotic prescriptions in tonsillitis leaves room for an increased use of RADTs and, as a consequence, for a decreased use of antibiotics in risk-averse GPs using a RADT. RADTs indeed decrease diagnostic uncertainty, in accordance with previous findings.[6-9, 12] These tests are thus a very useful strategy to decrease unnecessary antibiotic prescriptions. Since the financial risk aversion domain was frequently involved, financial incentives regarding antibiotic use might have an impact on practices.

Two practical strategies could then decrease GPs' diagnostic uncertainty: the use of RADT and the teaching of communication skills (how to communicate with a patient in case of diagnostic uncertainty). Hrisos et al. indeed demonstrated that a theory-based intervention ("persuasive communication") resulted in lower rates of antibiotic prescribing on patient scenarios compared to a control group for upper respiratory tract infections, partly by reducing the GPs' risk perception.[13] RADTs can also support GPs' explanations to the patients that antibiotics are unnecessary.[9, 12] Delayed prescriptions may also help, as GPs can offer patients easy access to an antibiotic at a later time.[8, 9]

Our study brings out original findings, and is the first, to the best of our knowledge, to have assessed the risk-aversion behaviour of physicians using a standardised measure scale. It is based on declarative data, and not on real practices, and this could be a limitation; however, standardised questions allowed us to assess the true impact of risk aversion. Furthermore, clinical vignettes have been shown to be a valid tool for measuring the quality of physician practice.[14]

In conclusion, RADTs for tonsillitis are a powerful tool to decrease diagnostic uncertainty among GPs, and to reduce unnecessary antibiotic prescriptions. Risk-aversion has then a dual effect: on the one hand, it induces GPs to use more RADTs (and as a consequence to prescribe less antibiotics), but

it also induces GPs to prescribe more antibiotics on the other hand when RADTs are not used. These results show the importance of RADT to struggle against “uncertainty avoidance”.

Table 1 : Socio-demographic characteristics of the 1136 General Practitioners (GPs).

GPs' characteristics		**%**
Gender	Male	72.8
	Female	27.2
Age (years)	< 45	20.9
	45-54	35.9
	> 54	43.2
Medical practice characteristics		
Location of practice	Urban	21.0
	Peri-urban	18.5
	Rural	60.5
Volume of activity (number of annual consultations)	< 2849	20.4
	2849 – 5494	54.3
	> 5494	25.3
Indicators of good practice		
Awareness and use of tonsillitis guidelines	Yes	69.4
	No	30.6
Use of a RADT in the last patient	Yes	59.5
	No	40.5
Good antibiotic prescription practices among GPs using a RADT	Yes	98.4
	No	1.6
Indicator of poor practice		
Antibiotic prescriptions among GPs not using a RADT	Yes	50.9
	No	49.1
GPs' risk-aversion behaviour		
Daily life	Risk-averse	42.1

	Risk-seeking	57.9
Medical behaviour regarding patients' health	Risk-averse	67.6
	Risk-seeking	32.4
Personal finances	Risk-averse	59.3
	Risk-seeking	40.7

RADT : Rapid Antigen Diagnostic Test

Table 2 : Association between declared practices regarding tonsillitis and risk aversion behaviour, in multivariate analysis (N= 1136)

Variables	%	OR	%	OR	%	OR	%	OR
	Indicator 1 : Awareness and use of tonsillitis guidelines		**Indicator 2 : Use of a RADT in the last patient**		**Indicator 3 : Good antibiotic prescription practices among GPs using a RADT [a]**		**Indicator 4 : Antibiotic prescriptions among GPs not using a RADT [a]**	
GPs' characteristics								
Gender								
Male	66.6	1	55.4	1	98.1	1	54.7	1
Female	76.9	**1.47***	70.6	**1.63****	99.1	**1.28****	35.8	**1.32*****
Age								
< 45	78.8	1.36	75.1	**1.75****	100	**1.34****	36.3	**1.31****
45-54	72.0	1	60.9	1	97.6	1	44.4	1
> 54	62.4	**0.70***	50.8	**0.68****	97.9	**0.77****	59.0	**0.73*****
Location of practice								
Urban	65.7	0.88	60.7	1.25	99.6	1.15	55.4	1.08
Peri-urban	73.3	1.20	66.6	**1.51***	99.4	**1.28****	51.1	**1.21***
Rural	69.5	1	57.0	1	97.6	1	49.5	1
Volume of activity								
< 2849	66.4	0.78	55.3	**0.69***	98.6	**0.77***	49.5	0.82
2849-5494	70.9	1	63.6	1	98.4	1	51.6	1
> 5494	68.6	0.97	54.2	**0.74***	98.0	**0.80***	50.9	0.87

Domains of risk-aversion								
Daily life								
Risk-averse	70.1	1.06	60.9	1.10	97.8	0.74	55.5	**1.21***
Risk-seeking	68.2	1	59.4	1	98.9	1	51.8	1
Patients' health								
Risk-averse	72.6	**1.50****	60.7	1.14	99.4	**1.64***	49.6	1.01
Risk-seeking	61.4	1	57.4	1	96.3	1	57.5	1
Personal finances								
Risk-averse	73.1	**1.47****	63.1	**1.39****	98.4	0.97	51.9	1.16
Risk-seeking	64.9	1	55.7	1	98.5	1	52.1	1

* : P<.05 ; ** : P<.01 ; *** : P<.001

RADT : Rapid Antigen Diagnostic Test

[a] Sample selection models in two steps were performed to take into account the selection effect of the sample ; for these models, all three domains of risk aversion were entered in the model 1 by 1. OR cannot be obtained directly from these models, but they were calculated from the marginal effects.

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COMPETING INTERESTS STATEMENT

The authors declare no conflicts of interest.

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AUTHORSHIP/CONTRIBUTION

C.P., A.N. and B.V. designed the study. C.P. wrote the article. A.M.L. performed the statistical analysis. A.M.L., A.N., B.V. and P.V. reviewed the study protocol and the article.

DATA SHARING

The survey data are not currently publicly available.

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QUESTIONNAIRE

Antibiotic use - Tonsillitis

1. In your last patient with tonsillitis, aged 3 to 16 years old, did you use a rapid antigen diagnostic test (RADT) ?

A. Yes
B. No *=> go to question 3*
C. Do not know *(answer not cited by the investigator)*

If yes,

2. The result of the RADT was :

A. Positive
B. Negative
C. Do not know *(answer not cited by the investigator)*

3. Did you prescribe an antibiotic ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

4. Are you aware of national guidelines regarding the management of upper respiratory tract infections in children ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

If yes,

5. Did you take these guidelines into account to manage your last paediatric patient with tonsillitis ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

Risk aversion attitudes

In this part, we will ask you some questions regarding your attitudes towards situations in a context of uncertainty, and their impact on your practices.
Please take into account the perceptions you have from yourself.

In the following domains, where would you place yourself, from 0 to 10, 0 being « not at all inclined to take risks » and 10 being « totally inclined to take risks » ?

1. First, in the different domains of daily life :

0 / 1 / 2 ..... 9 / 10

2. Then, for the management of your personal finances :

0 / 1 / 2 ..... 9 / 10

3. Finally, regarding your medical behaviour for your patients' health :

0 / 1 / 2 ..... 9 / 10

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	*5*
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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RESEARCH ARTICLE

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Short title: GPs'risk attitudes and tonsillitis

ABSTRACT (282 words)

Objectives - We tested the following hypotheses: (i) risk-averse general practitioners (GPs) might use more Rapid Antigen Diagnostic Tests (RADTs) in tonsillitis in children, probably to decrease their diagnostic uncertainty regarding the aetiology of the disease (viral versus due to group A *Streptococcus*); (ii) and GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

Design, setting and participants - We conducted in 2012 a cross-sectional survey of a nationwide French representative sample of 1093 GPs.

Outcome measures - Multivariate analyses adjusted on the four stratification variables (age, gender, location and volume of activity, i.e. the number of annual consultations) were performed in order to identify the risk domains associated with indicators of good or poor practice.

Results – 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last paediatric tonsillitis case. 59.1% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis; 29.7% of these tests were positive. Among the GPs who used a RADT, 30.7% prescribed an antibiotic; 98.3% did either prescribe an antibiotic because of a positive RADT result, or did not prescribe an antibiotic in view of a negative result. Among the GPs who did not use a RADT, 50.7% prescribed an antibiotic. In multivariate analyses, risk-averse GPs declared being more aware of and compliant with guidelines (OR=1.56, P<.01), and used RADTs more often for their last patient (OR=1.30, P<.05). Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-tolerant doctors (OR=1.18, P<.05).

Conclusions – Individual risk attitudes influenced GPs' practices in tonsillitis, particularly the use of RADTs and antibiotic prescriptions.

ARTICLE SUMMARY

Article focus :

- Risk-averse general practitioners (GPs) might use more Rapid Antigen Diagnostic Tests (RADTs) in tonsillitis in children, probably to decrease their diagnostic uncertainty regarding the aetiology of the disease (viral versus due to group A *Streptococcus*).
- GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

Key messages :

- Risk-averse GPs declared being more aware of and compliant with guidelines.
- Risk-averse GPs used RADTs more often in their last paediatric patient.
- Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-tolerant doctors.

Strengths and limitations of this study :

- First study to have assessed the impact of individual risk attitudes of physicians on antibiotic prescribing using a standardised measure scale.
- Based on declarative data, and not on real practices, but standardised questions allowed us to assess the true impact of individual risk attitudes and clinical vignettes have been shown to be a valid tool for measuring the quality of physician practice.

INTRODUCTION

Given the current worldwide bacterial resistance crisis, decreasing unnecessary antibiotic use is crucial. In France, 80% of all antibiotics used in humans are prescribed in the outpatient setting, and general practitioners (GPs) account for 71% of these prescriptions.[1]

Tonsillitis is one of the leading causes of antibiotic use in the outpatient setting.[2] Rapid Antigen Diagnostic Tests (RADTs) detecting group A streptococcal infections offer a useful mean to reduce unnecessary antibiotic prescriptions: the 2011 French guidelines recommend using these tests in all cases of tonsillitis in children ≥ 3 years old and prescribing antibiotics only in proven group A streptococcal infections (positive RADT result).[3] If a RADT is not available, the guidelines explicitely state that no antibiotic therapy is needed.[3] However, in France, RADTs are underused for patients presenting with tonsillitis.[4]

Non-compliance with guidelines can be explained by a variety of factors.[5] At country level, « uncertainty avoidance » was recently identified in multivariate analysis as one of the national cultural dimensions significantly associated with (inappropriate) use of antibiotics for colds/flu/sore throats,[6] confirming previous findings.[7] France is a country with a high uncertainty avoidance score.[6-7] At the individual level, recent reviews of qualitative studies identified diagnostic uncertainty as an important factor favouring antibiotic misuse.[8, 9] Risk aversion slightly differs from uncertainty avoidance, but, as a close concept largely used in economics, it was interesting to know whether it might play a role in antibiotic prescribing and the use of rapid diagnostic tests in tonsillitis. On the one hand, RADTs decrease diagnostic uncertainty, by establishing that the tonsillitis is bacterial (group A streptococcal infection). One may hypothesize that risk-averse GPs might use RADTs more often, possibly as a way to decrease their diagnostic uncertainty. On the other hand, if GPs are not using RADTs, clinical findings do not allow to reliably differentiate between viral and bacterial tonsillitis.[3] Thus, one may hypothesize that risk-averse GPs might prescribe more antibiotics when they are not using RADTs since they may be more sensitive to diagnostic uncertainty than risk-tolerant GPs. Consequently, diagnostic uncertainty might lead here to unnecessary antibiotic prescriptions.

In this survey of a nationwide French representative sample of GPs, we wanted to assess the following hypotheses, taking tonsillitis as an example: (i) risk-averse GPs might use more RADTs, probably to decrease their diagnostic uncertainty regarding the aetiology of the disease (viral versus due to group A *Streptococcus*); (ii) and GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

MATERIAL AND METHODS

Sampling

A panel of French GPs was constituted in June 2010. Its procedures have already been described elsewhere.[4] Briefly, 5170 GPs were selected by random sampling from the Ministry of Health's exhaustive database of health professionals in France. Sampling was stratified for location of the general practice (urban, peri-urban, or rural areas), gender, age (<49, 49–56, >56 years old) and the number of consultations (<2849, 2849-5494, >5494) in 2008. Of the 3888 contacted and eligible GPs, 1431 (36.8%) agreed to participate in the panel, i.e. to provide regular data on their activity and respond to 5 consecutive surveys on different topics during a 30-month period. Among the 1136 GPs who participated in the fifth national cross-sectional survey, conducted in Novembre 2012 (attrition rate between the first and fifth cross-sectional surveys: 20.6%), the results presented in this study are based on 1093 GPs (43 missing values).

Ethics Statement

The National Data Protection Authority (Commission Nationale Informatique et Libertés), responsible for ethical issues and protection of individual data in France, approved the panel and its procedures.

Procedure and questionnaire

Professional investigators contacted the GPs and interviewed them with computer-assisted telephone interview software, using a standardised questionnaire (supplementary file). It collected information about their professional characteristics, their practices regarding tonsillitis, and their individual risk attitudes in their daily life, concerning their personal finances and their medical behaviour regarding patients' health, using a Likert scale from 0 (not at all inclined to take risks) to 10 (totally inclined to take risks).[10, 11] We considered a scoring below 5 to be risk-averse.[10, 11] From the questionnaire we studied the following indicators of compliance with tonsillitis guidelines: awareness and use of national tonsillitis guidelines (indicator 1, reflecting good practice); use of a RADT in the last patient aged between 3-16 years presenting a tonsillitis (indicator 2, good practice); among GPs who declared using a RADT, antibiotic prescription in case of a positive RADT result and absence of antibiotic

prescription in case of a negative RADT result (indicator 3, good practice); and among GPs who did not use a RADT, prescription of an antibiotic (indicator 4, reflecting poor practice).

Statistical analysis

Due to the panel participants' characteristics, we weighted the data in order to obtain a representative sample of the national French GP population for age, gender, location and volume of activity. For indicators 1 and 2, multivariate logistic regressions adjusted on the four stratification variables were performed, and for indicators 3 and 4 sample selection models in two steps were used to identify the risk domains associated with indicators of good or poor practice in order to take into account the selection effect of the sample. In the first step, the dependent variable was the use of RADTs; in the second step, the dependent variable was either indicator 3 or 4. The stratification variables were computed in the first step of the model. All indicators were studied separately in each multivariate analysis. All analyses were performed using SAS 9.3®.

RESULTS

The socio-demographic characteristics of the participants are presented in Table 1. 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last tonsillitis case (indicator 1). 59.1% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis (indicator 2); 29.7% of these tests were positive and antibiotics were prescribed in 30.7% of the cases when a RADT was used. Among the GPs who used a RADT, 98.3% did either prescribe an antibiotic therapy because of a positive RADT result, or did not prescribe an antibiotic therapy in view of a negative result (indicator 3). Among the GPs who did not use a RADT, 50.7% prescribed an antibiotic (indicator 4).

Individual risk attitudes

The prevalence of risk-averse GPs for the three following domains was as follows: 40.1% for the daily life scale, 56.4% for the personal finances one and 64.5% for the medical behaviour regarding patients' health scale.

Association between practices and individual risk attitudes (Table 2)

Risk-averse GPs declared being more aware of and compliant with guidelines, and used RADTs more often in their last patient. Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-tolerant doctors.

GPs' socio-demographic characteristics also influenced practices : for example, female GPs and GPs <45 years old used RADTs more often in their last patient, but prescribed more antibiotics when a RADT was not used. GPs with a low volume of activity also used RADTs less often.

DISCUSSION

Our two hypotheses were verified: we found that risk-averse GPs were using RADTs more often and that a risk-averse behaviour was associated with an increase in antibiotic prescriptions when RADTs were not used. It is possible that the diagnostic uncertainty leading to unnecessary antibiotic prescriptions in tonsillitis leaves room for an increased use of RADTs and, as a consequence, for a decreased use of antibiotics in risk-averse GPs using a RADT. RADTs may indeed decrease diagnostic uncertainty, as suggested in the literature.[6-9, 12] RADTs allow the physician to differentiate between viral and bacterial (group A streptococcal infection) tonsillitis, whereas clinical findings do not allow a reliable distinction to be made between viral and bacterial tonsillitis.[3] These tests are thus a very useful strategy to decrease unnecessary antibiotic prescriptions. Since the financial risk domain was associated with indicators 1 and 2, financial incentives regarding RADT use, included in a pay-for-performance programme, might have an impact on practices.

Our study brings out original findings, and is the first, to the best of our knowledge, to have assessed the individual risk attitudes of physicians using a standardised measure scale. It is based on declarative data, and not on real practices, and this could be a limitation; however, standardised questions allowed us to assess the true impact of risk attitudes. Furthermore, clinical vignettes have been shown to be a valid tool for measuring the quality of physician practice.[13] Finally, our results might not be generalisable to other countries, since France is known for its high uncertainty avoidance score, which could be a possible driver behind the observed behaviour.[6-7]

In conclusion, RADTs for tonsillitis can reduce unnecessary antibiotic prescriptions, possibly because they decrease diagnostic uncertainty regarding the aetiology of tonsillitis. Risk-aversion has a dual effect: on the one hand, it induces GPs to use more RADTs (and as a consequence to prescribe less antibiotics), but it also induces GPs to prescribe more antibiotics on the other hand when RADTs are not used.

Table 1 : Socio-demographic characteristics of the 1093 General Practitioners (GPs).

GPs' characteristics		**%**
Gender	Male	73.0
	Female	27.0
Age (years)	< 45	21.2
	45-54	36.3
	> 54	42.5
Medical practice characteristics		
Location of practice	Urban	21.0
	Peri-urban	18.5
	Rural	60.5
Volume of activity (number of annual consultations)	< 2849	20.6
	2849 – 5494	54.3
	> 5494	25.1
Indicators of good practice		
Awareness and use of tonsillitis guidelines	Yes	69.4
	No	30.6
Use of a RADT in the last patient	Yes	59.1
	No	40.9
Good antibiotic prescription practices among GPs using a RADT	Yes	98.3
	No	1.7
Indicator of poor practice		
Antibiotic prescriptions among GPs not using a RADT	Yes	50.7
	No	49.3
GPs' risk attitudes		
Daily life	Risk-averse	40.1
	Risk-tolerant	57.2

	No answer[a]	2.7
Medical behaviour regarding patients' health	Risk-averse	64.5
	Risk-tolerant	32.3
	No answer	3.2
Personal finances	Risk-averse	56.4
	Risk-tolerant	40.3
	No answer	3.3

RADT : Rapid Antigen Diagnostic Test

[a] Corresponds to GPs who chose not to answer the question, and to GPs who answered « I do not know »

Table 2 : Association between declared practices regarding tonsillitis and individual risk attitudes, in multivariate analysis (N= 1093)

Variables	%	aOR	%	aOR	%	aOR	%	aOR
	Indicator 1 : Awareness and use of tonsillitis guidelines		**Indicator 2 : Use of a RADT in the last patient**		**Indicator 3 : Good antibiotic prescription practices among GPs using a RADT [a]**		**Indicator 4 : Antibiotic prescriptions among GPs not using a RADT [a]**	
GPs' characteristics								
Gender								
Male	66.6	1	55.2	1	98.0	1	54.3	1
Female	76.9	**1.46***	69.8	**1.58****	99.0	**1.28****	36.1	**1.32*****
Age								
< 45	78.6	1.35	75.1	**1.79****	100	**1.35****	37.0	**1.32****
45-54	72.1	1	60.5	1	97.6	1	44.3	1
> 54	62.4	**0.69***	50.0	**0.67****	97.9	**0.76****	58.4	**0.73*****
Location of practice								
Urban	65.9	0.91	60.3	1.28	99.6	1.16	54.9	1.09
Peri-urban	73.4	1.24	66.9	**1.59****	99.3	**1.29****	50.7	**1.22***
Rural	69.3	1	56.4	1	97.5	1	49.3	1
Volume of activity								
< 2849	66.8	0.82	54.6	**0.69***	98.6	**0.78***	49.9	0.82
2849-5494	70.7	1	63.2	1	98.4	1	51.4	1
> 5494	68.6	0.98	54.1	0.75	98.0	**0.82***	50.1	0.89

Domains of risk-aversion								
Daily life								
Risk-averse	69.7	0.96	60.4	0.94	97.8	0.76	54.1	**1.18***
Risk-tolerant	68.7	1	58.6	1	98.7	1	49.5	1
No answer	78.9	1.50	51.9	0.67	100	1.2	30.4	1.43
Patients'								
health	72.6	**1.56****	69.9	0.99	99.4	**1.67****	48.1	0.93
Risk-averse	61.5	1	57.9	1	96.0	1	56.8	1
Risk-tolerant	83.0	**2.90***	55.7	0.83	100	1.9	38.9	0.67
No answer								
Personal								
finances	72.8	**1.45****	62.7	**1.30***	98.4	0.99	50.7	1.11
Risk-averse	64.2	1	55.1	1	98.1	1	51.4	1
Risk-tolerant	73.6	1.46	48.2	0.71	100	0.75	42.6	0.68
No answer								

* : P<.05 ; ** : P<.01 ; *** : P<.001

RADT : Rapid Antigen Diagnostic Test

[a] Sample selection models in two steps were performed to take into account the selection effect of the sample ; for these models, all three domains of risk were entered in the model 1 by 1. Adjusted Odds Ratios cannot be obtained directly from these models, but they were calculated from the marginal effects.

ACKNOWLEDGEMENTS

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COMPETING INTERESTS STATEMENT

The authors declare no conflicts of interest.

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AUTHORSHIP/CONTRIBUTION

C.P., A.N. and B.V. designed the study. C.P. wrote the article. A.M.L. performed the statistical analysis. A.M.L., A.N., B.V. and P.V. reviewed the study protocol and the article.

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QUESTIONNAIRE

Antibiotic use - Tonsillitis

1. In your last patient with tonsillitis, aged 3 to 16 years old, did you use a rapid antigen diagnostic test (RADT) ?

A. Yes
B. No *=> go to question 3*
C. Do not know *(answer not cited by the investigator)*

If yes,

2. The result of the RADT was :

A. Positive
B. Negative
C. Do not know *(answer not cited by the investigator)*

3. Did you prescribe an antibiotic ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

4. Are you aware of national guidelines regarding the management of upper respiratory tract infections in children ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

If yes,

5. Did you take these guidelines into account to manage your last paediatric patient with tonsillitis ?

A. Yes
B. No
C. Do not know *(answer not cited by the investigator)*

Risk aversion attitudes

In this part, we will ask you some questions regarding your attitudes towards situations in a context of uncertainty, and their impact on your practices.
Please take into account the perceptions you have from yourself.

In the following domains, where would you place yourself, from 0 to 10, 0 being « not at all inclined to take risks » and 10 being « totally inclined to take risks » ?

1. First, in the different domains of daily life :

0 / 1 / 2 ..... 9 / 10

2. Then, for the management of your personal finances :

0 / 1 / 2 ..... 9 / 10

3. Finally, regarding your medical behaviour for your patients' health :

0 / 1 / 2 ..... 9 / 10

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	*5*
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

RESEARCH ARTICLE

Cross-sectional survey : Risk-averse French GPs use more rapid-antigen diagnostic tests in tonsillitis in children

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Keywords : antibiotic prescription ; diagnosis ; near-patient testing ; point-of-care test ; risk aversion

Body text: ~~1365~~ 1493 words

134 references, 2 Tables

Short title: GPs' ~~risk aversion behaviour~~risk attitudes and tonsillitis

ABSTRACT (28264 words)

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Design, setting and participants - We conducted in 2012 a cross-sectional survey of a nationwide French representative sample of 1093 1136 GPs.

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Results – 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last paediatric tonsillitis case. 59.15% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis; 29.73% of these tests were positive. Among the GPs who used a RADT, 30.7% prescribed an antibiotic; 98.34% did either prescribe an antibiotic because of a positive RADT result, or did not prescribe an antibiotic in view of a negative result. Among the GPs who did not use a RADT, 50.79% prescribed an antibiotic. In multivariate analyses, risk-averse GPs declared being more aware of and compliant with guidelines (OR=1.560, P<.01), and used RADTs more often in for their last patient (OR=1.309, P<.051). Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-seeking tolerant doctors (OR=1.1821, P<.05).

Conclusions – RADTs for tonsillitis are a powerful tool to decrease diagnostic uncertainty and unnecessary antibiotic prescriptions among GPsIndividual risk attitudes influenced GPs' practices in tonsillitis, particularly the use of RADTs and antibiotic prescriptions.

ARTICLE SUMMARY

Article focus :

- Risk-averse general practitioners (GPs) might use more Rapid Antigen Diagnostic Tests (RADTs) in tonsillitis in children, probably ~~in order~~ to decrease their diagnostic uncertainty regarding the aetiology of the disease (viral versus due to group A *Streptococcus*).
- GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

Key messages :

- Risk-averse GPs declared being more aware of and compliant with guidelines.
- Risk-averse GPs used RADTs more often in their last paediatric patient.
- Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-~~seeking~~ tolerant doctors.

Strengths and limitations of this study :

- First study to have assessed the impact of ~~risk-aversion behaviour~~individual risk attitudes of physicians on antibiotic prescribing using a standardised measure scale.
- Based on declarative data, and not on real practices, but standardised questions allowed us to assess the true impact of ~~risk aversion~~individual risk attitudes and clinical vignettes have been shown to be a valid tool for measuring the quality of physician practice.

INTRODUCTION

Given the current worldwide bacterial resistance crisis, decreasing unnecessary antibiotic use is crucial. In France, 80% of all antibiotics used in humans are prescribed in the outpatient setting, and general practitioners (GPs) account for 71% of these prescriptions.[1]

Tonsillitis is one of the leading causes of antibiotic use in the outpatient setting.[2] Rapid Antigen Diagnostic Tests (RADTs) detecting group A streptococcal infections offer a useful mean to reduce unnecessary antibiotic prescriptions: the 2011 French guidelines recommend using these tests in all cases of tonsillitis in children ≥ 3 years old and prescribing antibiotics only in proven group A streptococcal infections (positive RADT result).[3] If a RADT is not available, the guidelines explicitely state that no antibiotic therapy is needed.[3] However, in France, RADTs are underused for patients presenting with tonsillitis.[4]

Non-compliance with guidelines can be explained by a variety of factors.[5] ~~Several studies suggest that risk aversion may be a driver for unnecessary antibiotic prescriptions and non-compliance with guidelines regarding antibiotic prescriptions.~~ At country level, « uncertainty avoidance » was recently identified in multivariate analysis as one of the national cultural dimensions significantly associated with (inappropriate) use of antibiotics for colds/flu/sore throats,[6] confirming previous findings.[7] France is a country with a high uncertainty avoidance score.[6-7] At the individual level, recent reviews of qualitative studies identified diagnostic uncertainty as an important factor favouring antibiotic misuse.[8, 9] Risk aversion slightly differs from uncertainty avoidance, but, as a close concept largely used in economics, it was interesting to know whether it might play a role in antibiotic prescribing and the use of rapid diagnostic tests in tonsillitis. On the one hand, RADTs decrease diagnostic uncertainty, by establishing that the tonsillitis is bacterial (group A streptococcal infection). One may hypothesize that risk-averse GPs might use RADTs more often, possibly as a way to decrease their diagnostic uncertainty. On the other hand, if GPs are not using RADTs, clinical findings do not allow to reliably differentiate between viral and bacterial tonsillitis.[3] Thus, one may hypothesize that risk-averse GPs might prescribe more antibiotics when they are not using RADTs since they may be more sensitive to diagnostic uncertainty than risk-tolerant GPs. Consequently, diagnostic uncertainty might lead here to unnecessary antibiotic prescriptions.

In this survey of a nationwide French representative sample of GPs, we wanted to assess the following hypotheses, taking tonsillitis as an example: (i) risk-averse GPs might use more RADTs, probably ~~in order~~ to decrease their diagnostic uncertainty regarding the aetiology of the disease (viral versus due to group A *Streptococcus*); (ii) and GPs not using a RADT might prescribe more antibiotics when they are risk-averse.

MATERIAL AND METHODS

Sampling

A panel of French GPs was constituted in June 2010. Its procedures have already been described elsewhere.[4] Briefly, 5170 GPs were selected by random sampling from the Ministry of Health's exhaustive database of health professionals in France. Sampling was stratified for location of the general practice (urban, peri-urban, or rural areas), gender, age (<49, 49–56, >56 years old) and the number of consultations (<2849, 2849-5494, >5494) in 2008. Of the 3888 contacted and eligible GPs, 1431 (36.8%) agreed to participate in the panel, i.e. to provide regular data on their activity and respond to 5 consecutive surveys on different topics during a 30-month period. Among the 1136 GPs who participated in the fifth national cross-sectional survey, conducted in Novembre 2012 (attrition rate between the first and fifth cross-sectional surveys: 20.6%), the results presented in this study are based on 1093 GPs (43 missing values). ~~The results presented in this study are based on the 1136 GPs who participated in the fifth national cross-sectional survey, conducted in Novembre 2012 (attrition rate between the first and fifth cross-sectional surveys: 20.6%).~~

Ethics Statement

The National Data Protection Authority (Commission Nationale Informatique et Libertés), responsible for ethical issues and protection of individual data in France, approved the panel and its procedures.

Procedure and questionnaire

Professional investigators contacted the GPs and interviewed them with computer-assisted telephone interview software, using a standardised questionnaire (supplementary file). It collected information about their professional characteristics, their practices regarding tonsillitis, and their individual risk ~~aversion~~ attitudes ~~for~~ in their daily life ~~in general~~, concerning their personal finances and their medical behaviour regarding patients' health, using a Likert scale from 0 (not at all inclined to take risks) to 10 (totally inclined to take risks).[10, 11] We considered a scoring below 5 to be risk-averse.[10, 11] From the questionnaire we studied the following indicators of compliance with tonsillitis guidelines: awareness and use of national tonsillitis guidelines (indicator 1, reflecting good practice); use of a

RADT in the last patient aged between 3-16 years presenting a tonsillitis (indicator 2, good practice); among GPs who declared using a RADT, antibiotic prescription in case of a positive RADT result and absence of antibiotic prescription in case of a negative RADT result (indicator 3, good practice); and among GPs who did not use a RADT, prescription of an antibiotic (indicator 4, reflecting poor practice).

Statistical analysis

Due to the panel participants' characteristics, we weighted the data in order to obtain a representative sample of the national French GP population for age, gender, location and volume of activity. For indicators 1 and 2, multivariate logistic regressions adjusted on the four stratification variables were performed, and for indicators 3 and 4 sample selection models in two steps were used to identify the risk ~~aversion~~ domains associated with indicators of good or poor practice in order to take into account the selection effect of the sample. In the first step, the dependent variable was the use of RADTs; in the second step, the dependent variable was either indicator~~s~~ 3 or 4. The stratification variables were computed in the first step of the model. All indicators were studied separately in each multivariate analysis. All analyses were performed using SAS 9.3®.

RESULTS

The socio-demographic characteristics of the participants are presented in Table 1. 69.4% of GPs were aware of national guidelines regarding tonsillitis and declared they had taken these guidelines into account for their last tonsillitis case (indicator 1). 59.15% declared they used a RADT in their last patient aged between 3-16 years presenting with tonsillitis (indicator 2); 29.73% of these tests were positive and antibiotics were prescribed in 30.7% of the cases when a RADT was used. Among the GPs who used a RADT, 98.34% did either prescribe an antibiotic therapy because of a positive RADT result, or did not prescribe an antibiotic therapy in view of a negative result (indicator 3). Among the GPs who did not use a RADT, 50.79% prescribed an antibiotic (indicator 4).

~~Risk aversion behaviour~~Individual risk attitudes

The prevalence of risk-averse GPs for the three following domains was as follows: 402.1% for the daily life scale, 569.43% for the personal finances one and 647.56% for the medical behaviour regarding patients' health scale.

Association between practices and individual risk ~~aversion behaviour~~attitudes (Table 2)

Risk-averse GPs declared being more aware of and compliant with guidelines, and used RADTs more often in their last patient. Among GPs not using a RADT in their last patient, risk-averse GPs prescribed more antibiotics compared to risk-~~seeking~~ tolerant doctors.

GPs' socio-demographic characteristics also influenced practices : for example, female GPs and GPs <45 years old used RADTs more often in their last patient, but prescribed more antibiotics when a RADT was not used. GPs with a low volume of activity also used RADTs less often.

DISCUSSION

Our two hypotheses were verified: we found that risk-averse GPs were using RADTs more often and that a risk-aversion behaviour was associated with an increase in antibiotic prescriptions when RADTs were not used. Since the literature suggests that risk aversion may be a driver for unnecessary antibiotic prescriptions, the leverage effect of RADTs appears to be all the more powerful since GPs are risk-averse. It seems is possible that the diagnostic uncertainty leading to unnecessary antibiotic prescriptions in tonsillitis leaves room for an increased use of RADTs and, as a consequence, for a decreased use of antibiotics in risk-averse GPs using a RADT. RADTs may indeed decrease diagnostic uncertainty, in accordance with as suggested in the literature previous findings.[6-9, 12] RADTs allow the physician to differentiate between viral and bacterial (group A streptococcal infection) tonsillitis, whereas clinical findings do not allow a reliable distinction to be made between viral and bacterial tonsillitis.[3] These tests are thus a very useful strategy to decrease unnecessary antibiotic prescriptions. Since the financial risk aversion domain was frequently involvedassociated with indicators 1 and 2, financial incentives regarding antibiotic RADT use, included in a pay-for-performance programme, use might have an impact on practices.

Two practical strategies could then decrease GPs' diagnostic uncertainty: the use of RADT and the teaching of communication skills (how to communicate with a patient in case of diagnostic uncertainty). Hrisos et al. indeed demonstrated that a theory-based intervention ("persuasive communication") resulted in lower rates of antibiotic prescribing on patient scenarios compared to a control group for upper respiratory tract infections, partly by reducing the GPs' risk perception.[13] RADTs can also support GPs' explanations to the patients that antibiotics are unnecessary.[9, 12] Delayed prescriptions may also help, as GPs can offer patients easy access to an antibiotic at a later time.[8, 9]

Our study brings out original findings, and is the first, to the best of our knowledge, to have assessed the risk-aversion behaviourindividual risk attitudes of physicians using a standardised measure scale. It is based on declarative data, and not on real practices, and this could be a limitation; however, standardised questions allowed us to assess the true impact of risk aversionattitudes. Furthermore, clinical vignettes have been shown

to be a valid tool for measuring the quality of physician practice.[~~14~~13] Finally, our results might not be generalisable to other countries, since France is known for its high uncertainty avoidance score, which could be a possible driver behind the observed behaviour.[6-7]

In conclusion, RADTs for tonsillitis can reduce unnecessary antibiotic prescriptions, possibly because they~~are a powerful tool to~~ decrease diagnostic uncertainty regarding the aetiology of tonsillitis ~~among GPs, and to reduce unnecessary antibiotic prescriptions~~. Risk-aversion has ~~then~~ a dual effect: on the one hand, it induces GPs to use more RADTs (and as a consequence to prescribe less antibiotics), but it also induces GPs to prescribe more antibiotics on the other hand when RADTs are not used. ~~These results show the importance of RADT to struggle against "uncertainty avoidance".~~

Table 1 : Socio-demographic characteristics of the ~~1136~~ 1093 General Practitioners (GPs).

GPs' characteristics		**%**
Gender	Male	7~~3~~2.0~~8~~
	Female	27.0~~2~~
Age (years)	< 45	2~~1~~10.2~~9~~
	45-54	3~~6~~65.3~~9~~
	> 54	4~~2~~23.5~~2~~
Medical practice characteristics		
Location of practice	Urban	21.0
	Peri-urban	18.5
	Rural	60.5
Volume of activity (number of annual consultations)	< 2849	20.6~~4~~
	2849 – 5494	54.3
	> 5494	25.1~~3~~
Indicators of good practice		
Awareness and use of tonsillitis guidelines	Yes	69.4
	No	30.6
Use of a RADT in the last patient	Yes	59.1~~5~~
	No	40.9~~5~~
Good antibiotic prescription practices among GPs using a RADT	Yes	98.3~~4~~
	No	1.7~~6~~
Indicator of poor practice		
Antibiotic prescriptions among GPs not using a RADT	Yes	50.7~~9~~
	No	49.3~~1~~
GPs' risk attitudes ~~aversion behaviour~~		
Daily life	Risk-averse	40~~2~~.1
	Risk-	57.2

	~~seeking~~tolerant	2.7~~9~~
	No answer[a]	
Medical behaviour regarding patients' health	Risk-averse	64.5~~7.6~~
	Risk-tolerant~~seeking~~	32.3
		3.2~~4~~
	No answer	
Personal finances	Risk-averse	56~~9~~.4~~3~~
	Risk-tolerant~~seeking~~	40.3
		3.3~~7~~
	No answer	

RADT : Rapid Antigen Diagnostic Test

[a] Corresponds to GPs who chose not to answer the question, and to GPs who answered « I do not know »

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Table 2 : Association between declared practices regarding tonsillitis and individual risk ~~aversion behaviour~~attitudes, in multivariate analysis (N= ~~1136~~1093)

Variables	%	aOR	%	aOR	%	aOR	%	aOR
	Indicator 1 : Awareness and use of tonsillitis guidelines		**Indicator 2 : Use of a RADT in the last patient**		**Indicator 3 : Good antibiotic prescription practices among GPs using a RADT** [a]		**Indicator 4 : Antibiotic prescriptions among GPs not using a RADT** [a]	
GPs' characteristics								
Gender								
Male	66.6	1	55.24	1	98.01	1	54.37	1
Female	76.9	**1.467***	6970.86	**1.5863****	99.01	**1.28****	365.18	**1.32*****
Age								
< 45	78.68	1.356	75.1	**1.795****	100	**1.354****	376.03	**1.321****
45-54	72.10	1	60.59	1	97.6	1	44.34	1
> 54	62.4	**0.6970***	50.08	**0.678****	97.9	**0.767****	58.490	**0.73*****
Location of practice								
Urban	65.97	0.9188	60.37	1.285	99.6	1.165	54.95.4	1.098
Peri-urban	73.43	1.240	66.96	**1.59*1***	99.34	**1.298****	50.71.1	**1.221***
Rural	69.35	1	567.40	1	97.56	1	49.35	1
Volume of activity								
< 2849	66.84	0.8278	545.63	**0.69***	98.6	**0.787***	49.95	0.82

2849-5494	70.79	1	63.26	1	98.4	1	51.46	1
> 5494	68.6	0.987	54.12	0.754*	98.0	**0.820***	50.19	0.897
Domains of risk-aversion								
Daily life								
Risk-averse	6970.71	0.961.06	60.49	0.941.10	97.8	0.764	54.15.5	**1.18211***
Risk-tolerantseeking	68.7	1	589.6	1	98.7	1	49.5	1
No answer	78.92	1.50	51.94	0.67	1009	1.2	30.451.8	1.43
Patients' health								
Risk-averse	72.6	**1.560****	690.97	0.991.14	99.4	**1.67*4***	48.19.6	0.931.01
Risk-tolerantseeking	61.5	1	57.9	1	96.0	1	56.8	1
No answer	83.04	**2.90***	55.74	0.83	1003	1.9	38.97.5	0.67
Personal finances								
Risk-averse	723.81	**1.457****	623.71	**1.309***	98.4	0.997	50.71.9	1.116
Risk-tolerantseeking	64.2	1	55.1	1	98.1	1	51.4	1
No answer	73.69	1.46	48.27	0.71	1005	0.75	42.62.1	0.68

* : P<.05 ; ** : P<.01 ; *** : P<.001

RADT : Rapid Antigen Diagnostic Test

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[a] Sample selection models in two steps were performed to take into account the selection effect of the sample ; for these models, all three domains of risk aversion were entered in the model 1 by 1. Adjusted OOdds Ratios cannot be obtained directly from these models, but they were calculated from the marginal effects.

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COMPETING INTERESTS STATEMENT

The authors declare no conflicts of interest.

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AUTHORSHIP/CONTRIBUTION

C.P., A.N. and B.V. designed the study. C.P. wrote the article. A.M.L. performed the statistical analysis. A.M.L., A.N., B.V. and P.V. reviewed the study protocol and the article.

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