Using patient and general practice characteristics to explain variations in cervical smear uptake rates

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Abstract

***Objectives*—To produce practice and patient variables for general practices from census and family health services authority data, and to determine the importance of these variables in explaining variation in cervical smear uptake rates between practices.**

***Design*—Population based study examining variations in cervical smear uptake rates among 126 general practices using routine data.**

***Setting*—Merton, Sutton, and Wandsworth Family Health Services Authority, which covers parts of inner and outer London.**

***Main outcome measure*—Percentage of women aged 25-64 years registered with a general practitioner who had undergone a cervical smear test during the five and a half years preceding 31 March 1992.**

***Results*—Cervical smear uptake rates varied from 16·5% to 94·1%. The estimated percentage of practice population from ethnic minority groups correlated negatively with uptake rates ($r=-0·42$), as did variables associated with social deprivation such as overcrowding ($r=-0·42$), not owning a car ($r=-0·41$), and unemployment ($r=-0·40$). Percentage of practice population under 5 years of age correlated positively with uptake rate ($r=0·42$). Rates were higher in practices with a female partner than in those without (66·6% *v* 49·1%; difference 17·5% (95% confidence interval 10·5% to 24·5%)), and in computerised than in non-computerised practices (64·5% *v* 50·5%; 14·0% (6·4% to 21·6%)). Rates were higher in larger practices. In a stepwise multiple regression model that explained 52% of variation, five factors were significant predictors of uptake rates: presence of a female partner; children under 5; overcrowding; number of women aged 35-44 as percentage of all women aged 25-64; change of address in past year.**

***Conclusions*—Over half of variation in cervical smear uptake rates can be explained by patient and practice variables derived from census and family health services authority data; these variables may have a role in explaining variations in performance of general practices and in producing adjusted measures of practice performance. Practices with a female partner had substantially higher uptake rates.**

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Introduction

There are wide variations in the use made of primary care services by patients,[1,2] and in the performance of general practitioners.[3] These variations may be due either to differences in the characteristics of the patients registered with practices (patient factors) or to differences in the way in which general practitioners deliver care (practice factors). Measures of the social and demographic characteristics of general practice populations may help to explain some of the variations seen in the use made of services and in the performance of general practitioners. Such measures may also provide a fairer basis for allocating resources to general practices than current methods.[4,5] Data from general practices have been combined with census data to produce sociodemographic variables for individual practices.[6-8] Advances in information technology make possible the production of such variables for every general practice in a family health services authority.

This study had two main aims. Firstly, to produce sociodemographic variables for each general practice administratively accountable to Merton, Sutton, and Wandsworth Family Health Services Authority by using data from the authority's age-sex register and the 1991 census, and, secondly, to determine the importance of these patient variables and practice factors such as the presence of a female partner in

Box 1—Production of indicator for chronic ill health for a hypothetical practice

Consider a hypothetical practice with a population of 5000 living in five different wards for which we wish to calculate the percentage of patients reporting chronic illness:

(A) Ward	(B) Proportion of chronically ill in ward	(C) No of patients in practice	(D) No of practice patients in ward expected to report chronic illness
1	0·10	500	50
2	0·20	1000	200
3	0·15	3000	450
4	0·20	300	60
5	0·20	200	40
Total		5000	800

1 Multiply the number of people resident in each ward (column C) by the proportion of people reporting chronic illness in that ward (column B) to produce column D
2 Summate column D to give the expected number of people reporting chronic illness for the practice
3 Divide the expected number of people reporting chronic illness by the practice population and multiply by 100 to give the expected percentage of the practice population reporting chronic illness
4 The practice population is 5000, of which 800 patients (16%) are expected to report chronic illness

explaining the variation in cervical smear uptake rates among the practices. The authority covers parts of inner and outer London and is coterminous with the three London boroughs of Merton, Sutton, and Wandsworth.

Methods

The family health services authority provided the following data for 128 practices that were administratively accountable to it: total list size; number of patients resident in Merton, Sutton, and Wandsworth who registered with the practice in 1992; number and sex of partners; and whether the practice was computerised. Eighty nine per cent (588 926/658 246) of the patients registered with these practices lived in Merton, Sutton, or Wandsworth.

CALCULATION OF SOCIODEMOGRAPHIC VARIABLES FOR PRACTICE POPULATIONS

The family health services authority provided a database file containing the age, sex, general practice, and electoral ward of residence of 640 720 people resident in Merton, Sutton, and Wandsworth who were registered with a general practitioner on 31 March 1993 (electoral ward was not available for four residents). A total of 588 926 (92%) of these people were registered with the 128 general practices administratively accountable to the authority. The authority's age-sex register was cross tabulated by ward of residence and general practice to give the number of patients resident in each of the 67 wards in Merton, Sutton, and Wandsworth for each general practice. The resulting cross tabulation was imported into a spreadsheet that also contained a number of census variables for these electoral wards. Box 1 illustrates the calculation of the percentage of chronically ill patients for a hypothetical practice. Other census derived variables (listed in box 2) were calculated in the same way. Eight of these variables (identified in box 2) were used with national data from the 1991 census to produce a Jarman underprivileged area (UPA) 8 score[9 10] for each practice.

The authority's age-sex register was used to calculate the percentage of each practice population in the following categories: children under 5 years of age; women in age groups 25-34 years, 35-44 years, 45-54 years, and 55-64 years as a percentage of all women aged 25-64; percentage of practice population eligible for deprivation payments based on 1981 census data (which is the current basis of these payments); and percentage of practice population who would be eligible for deprivation payments on the basis of 1991 census data.

CALCULATION OF CERVICAL SMEAR UPTAKE RATE FOR PRACTICES

The cervical smear uptake rate for each practice was calculated as the number of women aged 25-64 who had undergone a cervical smear test during the five and a half years up to 31 March 1992 as a percentage of the total number of eligible women. These data were not available for one practice that was established recently, and another practice had no patients under 65 years of age; results are presented for the remaining 126 practices.

ASSOCIATION BETWEEN UPTAKE RATES AND VARIABLES

The cervical smear uptake rates for the practices were correlated with variables derived from the census and age-sex register by using Pearson's product moment correlation coefficient. Forwards stepwise multiple regression was then used to construct an explanatory model with cervical smear uptake rate as the dependent variable and the census derived sociodemographic variables and the practice variables as the independent variables.

Box 2—Sociodemographic variables derived for 126 general practices administratively accountable to Merton, Sutton, and Wandsworth Family Health Services Authority

Expected values calculated from authority's age-sex register and ward census data

Elderly alone*	Percentage of pensioners living alone
Children under 5 (expected)*	Percentage of patients aged under 5 years
One parent*	Percentage of patients living in one parent households
Unskilled*	Percentage of patients living in households where head of household is in socioeconomic group 11
Unemployed*	Percentage of economically active patients who are unemployed
Overcrowding*	Percentage of patients living in household with more than 1·5 persons per room
Change of address*	Percentage of patients who have changed address in past year
Born in NCP*	Percentage of patients living in household headed by person born in New Commonwealth or Pakistan
Deprivation 1981	Percentage of patients eligible for deprivation payments
Deprivation 1991	Percentage of patients eligible for deprivation payments on the basis of 1991 census data
Jarman UPA 8	Jarman UPA 8 score for practice
Chronic ill	Percentage of patients who report limiting long term illness
Not owner occupied	Percentage of patients living in households not owner occupied
No car	Percentage of patients living in households without a car
Ethnic minority	Percentage of patients belonging to non-white ethnic groups

Data obtained from age-sex register and other family health services authority sources

Children under 5 (actual)	Percentage of patients under 5 years of age
Women 25 to 34	Number of women aged 25 to 34 as percentage of all women aged 25 to 64
Women 35 to 44	Number of women aged 35 to 44 as percentage of all women aged 25 to 64
Women 45 to 54	Number of women aged 45 to 54 as percentage of all women aged 25 to 64
Women 55 to 64	Number of women aged 55 to 64 as percentage of all women aged 25 to 64
Patient registration rate	Number of patients resident in Merton, Sutton, and Wandsworth added to practice list in 1992 per 1000 patients resident in the area registered with practice on 1 April 1993
Patients per partner	Number of patients per partner

*Components of Jarman UPA 8 score.

Results

SOCIODEMOGRAPHIC VARIABLES

The practices varied widely in their sociodemographic characteristics (table 1). For example, the percentage of the practice population under 5 years of age varied 13-fold, from 0·9% to 12·2%, and the estimated percentage of the population belonging to an ethnic minority varied eightfold, from 4·7% to 36·2%. Two variables measured the percentage of the practice population under 5 years of age—one was estimated from census data and the other was obtained directly from the family health services authority age-sex register. The correlation between these two variables was 0·34 (P=0·0001).

CERVICAL SMEAR UPTAKE RATES

Of the 174 724 women eligible for a smear and registered with the 126 practices with data on uptake rates, 111 749 (64·0%) had undergone a cervical smear test during the five and a half years preceding 31 March 1992. Cervical smear uptake rates for individual practices ranged from 16·5% to 94·1% (median 62·9%, interquartile range 42·4% to 78·9%), an almost sixfold variation. The distribution of uptake rates was trimodal (fig 1); 59 (47%) practices achieved the lower rate target (50% of eligible women) and 28 (22%)

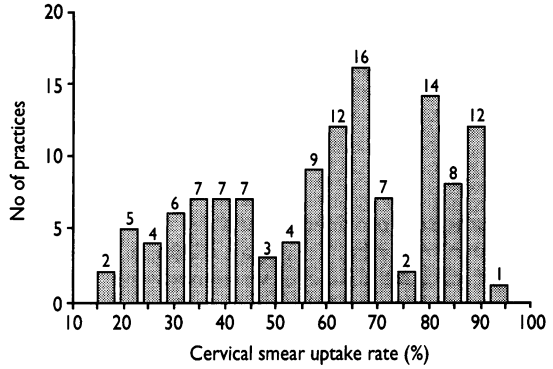

FIG 1—*Percentage cervical smear uptake rates in 126 general practices in Merton, Sutton, and Wandsworth family health services authority on 31 March 1992*

practices achieved the higher rate target (80% of eligible women); 39 (31%) practices failed to reach a target.

RELATION OF CERVICAL SMEAR UPTAKE RATES TO PRACTICE CHARACTERISTICS

Cervical smear uptake rates were higher in practices with at least one female partner (66·6% *v* 49·1%; difference 17·5% (95% confidence interval 10·5% to 24·5%)) and in computerised practices (64·5% *v* 50·5%; 14·0% (6·4% to 21·6%)). The uptake rate also increased with the number of partners (51% in single-handed practices, 56% in practices with two partners, 72% in practices with three or more partners; $P<0·0001$).

RELATION OF UPTAKE RATES WITH DERIVED VARIABLES

The strongest negative correlations were with the variables for ethnic minority population ($r=-0·42$) and for variables associated with social deprivation such as overcrowding ($r=-0·42$) (table I). There were also significant negative correlations with the Jarman UPA 8 score for the practices ($r=-0·39$) and with women aged 35-44 years as a percentage of all women aged 25-64 ($r=-0·21$). There was a strong positive correlation ($r=0·42$) with the percentage of the practice population under 5 years of age. There was no significant association with the number of patients per partner.

MULTIPLE REGRESSION ANALYSIS

The multiple correlation coefficient was 0·72, with five variables explaining 52% of the variation in cervical smear uptake (table II). Rates were 12·5% higher in practices with a female partner. The percentage of the practice population under 5 years of age was also a positive predictor of uptake, with an increase of one SD (1·81%) in this variable leading to a 6·7% increase in the predicted uptake rate for a practice. The variables for overcrowding, women aged 35-44, and change of address were negative predictors of uptake; increases of one SD in overcrowding (2·58%), women aged 35-44 (3·34%), and change of address (2·80%) led to falls of 7·5%, 6·1%, and 3·5% respectively in the predicted uptake rate for a practice. Size of practice and computerisation were not significant predictors of cervical smear uptake even though larger practices and computerised practices had substantially higher rates in the univariate analysis because such practices were more likely to have a female partner and to be located in affluent areas with low ethnic minority populations. Forward stepwise ordered polytomous logistic regression with cervical smear uptake rates divided into three categories ($<50\%$, 50-69·9%, $\geq 70\%$) gave the same five significant variables as multiple linear regression.

The residuals from the multiple regression model were normally distributed both on a normal plot and with a χ^2 goodness of fit test ($\chi^2=7·6$, df=9, $P=0·58$). Figure 2 compares the predicted and observed uptake rates. The mean values of the residuals from the multiple regression model were similar in the three boroughs, but the standard deviations of the residuals were higher in Wandsworth (mean (SD) 0·27% (16·1%)) than in Merton (−1·57% (11·0%)) or Sutton (0·44% (13·9%)).

Discussion

Cervical smear uptake rates varied nearly sixfold among the general practices in Merton, Sutton, and Wandsworth. Some of this variation may have been

TABLE II—*Forward stepwise regression model*

Variable	Cumulative *r*	Additional % of variance explained	Regression coefficient (SE)	P value
Children under 5 (actual %)	0·42	17·8	3·68 (0·76)	<0·0001
Overcrowding (%)	0·56	14·0	−2·91 (0·61)	<0·0001
Women aged 35-44 (%)	0·65	10·6	−1·83 (0·41)	<0·0001
Female partner*	0·71	7·9	12·5 (2·81)	<0·0001
Change of address (%)	0·72	2·0	−1·26 (0·56)	0·03

*Present = 1, absent = 0.

TABLE I—*Sociodemographic and practice variables for 126 practices administratively accountable to Merton, Sutton, and Wandsworth family health services authority and correlations between these variables and cervical smear uptake rate*

Variable	Mean	Minimum	25th centile	Median	75th centile	Maximum	Correlation with cervical smear uptake rate	P value
Children under 5 (actual %)	5·6	0·9	4·3	5·7	6·5	12·2	0·42	<0·0001
Overcrowding (%)	6·5	2·2	3·6	6·8	8·5	11·7	−0·42	<0·0001
Ethnic minority (%)	15·7	4·7	6·6	14·4	22·9	36·2	−0·42	<0·0001
Born in NCP (%)	13·5	3·5	6·3	12·3	18·8	32·4	−0·41	<0·0001
No car (%)	36·7	19·4	28·3	39·3	42·4	54·3	−0·41	<0·0001
Change of address (%)	12·9	7·3	10·3	13·6	15·2	17·6	−0·40	<0·0001
Unemployed (%)	9·8	5·1	7·0	10·1	11·8	15·8	−0·40	<0·0001
Jarman UPA 8 score	15·7	−5·3	7·4	17·7	23·2	33·0	−0·39	<0·0001
Not owner occupied (%)	36·3	9·9	26·4	38·9	43·5	60·3	−0·37	<0·0001
Unskilled (%)	2·5	0·7	1·7	2·5	3·1	5·0	−0·26	0·003
One parent (%)	4·7	1·8	3·4	4·3	5·6	10·0	−0·23	0·01
Women 35 to 44 (%)	24·7	16·4	22·7	24·6	26·9	35·0	−0·21	0·02
Elderly alone (%)	6·2	4·1	5·4	5·9	6·8	9·6	0·15	0·10
Patients per partner	2206	319	1813	2137	2707	3997	−0·14	0·12
Deprivation 1981 (%)	9·5	0·0	0·0	0·1	1·0	93·9	−0·11	0·21
Chronically ill (%)	10·7	8·4	9·9	10·4	11·1	15·9	−0·11	0·22
Patient registration rate (per 1000)*	177	25	94	121	187	1074	0·09	0·30
Deprivation 1991 (%)	11·6	0·0	0·4	1·8	11·9	76·3	−0·06	0·53
Children under 5 (expected %)	6·6	4·8	6·1	6·5	6·8	9·3	0·06	0·54
Women 25 to 34 (%)	38·7	19·1	31·8	36·9	44·5	70·5	0·05	0·56
Women 55 to 64 (%)	16·4	3·9	13·7	16·5	19·4	32·3	0·04	0·70
Women 45 to 54 (%)	20·2	8·8	17·1	21·0	23·3	31·2	0·01	0·92

*Data not available for one practice.

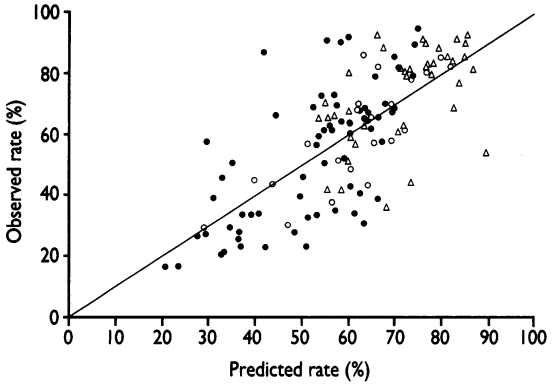

FIG 2—*Predicted versus observed cervical smear uptake rates in 126 general practices in Merton (○), Sutton (△), and Wandsworth (●) family health services authority*

artefactual owing to errors in the family health services authority's call-recall system, but most is likely to be real and due to either patient or practice factors. Uptake rates were negatively correlated with the ethnic minority variable and also with the variables associated with social deprivation. These findings are consistent with those from previous studies showing that general practitioners in deprived areas[11] or areas with large ethnic minority populations[12] have greater difficulty in achieving high cervical smear uptake rates. The variable for women aged 35-44 was also negatively correlated with uptake rates; this may be because women in this group have less contact with their general practitioners than women from other age groups.

One patient variable, the percentage of the practice population under 5 years of age, was positively correlated with the uptake rate. Presumably, this is a reflection of the percentage of women in a practice who have received a smear as part of maternity care during the preceding five years. Practices with a female partner, larger practices, and computerised practices also achieved higher uptake rates. Women may be more willing to undergo a smear test if this is done by a female doctor. Larger, computerised practices may have better call-recall systems for cervical smears and be more likely to employ a practice nurse.[13] The lack of an association between the number of patients per partner and the cervical smear uptake rate suggests that the way in which a practice organises its call-recall system is more important than list size in achieving high uptake rates.

In our multiple regression model five factors remained important: the variables for the percentage of the practice population under 5 years of age; overcrowding; change of address; percentage of women aged 35-44; and the presence of a female partner. Cervical smear uptake rates were 12·5% higher in practices with a female partner—if this relation is causal, appointing a female partner may be the most effective step a practice can take to raise its rate. The final model explained 52% of the variation in uptake rates. Some of the unexplained variation is undoubtedly due to inaccuracies in the cervical cytology data and the sociodemographic variables and to practice factors that cannot be measured easily, such as the importance a practice attaches to cervical cytology.

The residuals from the multiple regression analysis (the difference between the observed and predicted values) give an indication of how well a practice is performing compared with what is expected, and these could form the basis of an "adjusted" measure of performance. The inner city area of London has a high proportion of socially deprived residents[14] and people from ethnic minorities.[15] Population mobility is also a greater problem in inner city areas, and this reduces the efficiency of call-recall systems for cervical cytology.[16,17] Practices in such areas will experience greater difficulty in achieving high cervical cytology uptake rates. This raises important questions. Should family health services authorities take these problems into account when they assess practice performance? If so, should they adjust only for patient factors (as these are outside the control of the practice) or for practice factors (such as the presence of a female partner) as well? Many practices in Wandsworth (the inner city part of the authority) achieved high cervical cytology uptake rates (fig 2), demonstrating that good practices can perform well even in a difficult social environment. We may need to study how such practices organise their call-recall system for cervical cytology to develop methods of raising uptake rates in inner city areas.

Some aspects of our multiple regression model should be interpreted with caution. There were strong correlations between many of the census derived variables. For example, the variable for ethnic minority was highly correlated with variables associated with deprivation, such as overcrowding ($r=0·89$), unemployment ($r=0·79$), and no car ($r=0·71$). When we used ethnic minority in our multiple regression model instead of overcrowding, the model explained a similar percentage of the variation (50% *v* 52%). Consequently, we cannot exclude the ethnic variable as an important factor in influencing a practice's cervical smear uptake rate. In contrast, the presence of a female partner and the percentage of the practice population under 5 years of age remained significant predictors of uptake irrespective of which other variables were entered into the model.

LIMITATIONS OF VARIABLES

The census derived variables have several limitations. Firstly, our method uses census data for electoral wards and assumes that the patients registered with individual general practices are representative of their ward of residence. Electoral wards cover large areas and contain people from many different social classes and ethnic groups. The variables calculated using our method will be inaccurate if patients differ systematically in the way they choose their practice—for example, if ethnic minority patients register with practices that employ ethnic minority doctors, or mothers with young children register with practices that have a

Public health implications

- The performance of general practices varies widely—for example, in the cervical smear uptake rates they achieve
- Advances in information technology combined with the availability of data from the 1991 census allow the production of a range of sociodemographic variables for general practices
- These sociodemographic variables, when used in a multiple regression model with practice variables, explained over half the variation in cervical smear uptake rates among the general practices in Merton, Sutton, and Wandsworth Family Health Services Authority
- Practices with a female partner had substantially higher uptake rates even after other factors were adjusted for, suggesting that appointing a female partner may help raise a practice's cervical smear uptake rate
- Practices' sociodemographic variables may also have a role in planning primary care services and in allocating resources to general practices

female partner. We were able to validate one census variable (under 5 year olds) against the percentage of the practice population under 5 years of age on the family health services authority's age-sex register. There was a significant but weak correlation ($r=0{\cdot}34$) between the two, suggesting that this variable is only moderately well measured with census data for electoral wards. Using census data for enumeration districts instead of wards may improve the accuracy of this and the other census derived variables. We were not able to validate any of the other census variables for the practices and so do not know how accurately they were measured by our method.

Secondly, family health services authority age-sex registers are inaccurate.[18] For example, list inflation (more patients included on the age-sex register than are actually resident in the area) and incorrect addresses are common problems.[19] Thirdly, only patients residing within Merton, Sutton, and Wandsworth were included in the calculation of the variables; 11% (69 320/658 246) of the patients registered with the practices administratively accountable to Merton, Sutton, and Wandsworth family health services authority lived in other areas. The practice variables also need to be improved. For example, better data are required on practice nurses, because they may also influence the uptake rate for a practice. However, despite their limitations, using practice and socio-demographic variables derived from family health services authority data and the census to explain differences in the performance of general practitioners and to measure the need for health care in general practice populations seems promising and requires further evaluation, as does their potential role in producing adjusted measures of performance and allocating resources to general practices.

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THE NOBEL PRIZES

Competition to be first

The official collections of Nobel prize lectures do not contain photographs of the presentation ceremonies. If they did so the volume covering 1971-80 would inevitably show, together with many proud and smiling faces, two of the three 1977 winners for medicine looking distinctly uneasy in each other's presence. For there in the Stockholm Concert Hall, alongside Rosalyn Yalow, honoured for devising radioimmunoassay as a means of detecting tiny traces of hormones, were two of the most bitter rivals ever to share Alfred Nobel's prize for a single discovery.

Andrew Schally and Roger Guillemin, codiscoverers of the hypothalamic releasing factors, had just concluded a 21 year race that was characterised as much by their mediocre personal relations as by the stupendous technical demands of the work itself. The antipathy had several sources, but a major cause seems to have been the urbane Guillemin's inability to accept as a scientific equal someone who had once been his assistant.

The book that does reveal the personal dimension to Schally and Guillemin's extraordinary odyssey and relationship is Nicholas Wade's *The Nobel Duel* (Anchor Press/Doubleday, 1981). There, facing page 106, we see a radiant, beaming Rosalyn Yalow, with her two colaureates staring stonily in opposite directions. "Guillemin and Schally looked like men going to their execution," Wade writes. "Guillemin, a handsome face lined with age, seems stiff and ill at ease. He sits next to Yalow, looking straight ahead and scarcely moving. On the other side of him is Schally, who keeps fidgeting, not knowing what to do with his hands. His eyes dart relentlessly in all directions, except towards Guillemin. The two exchange neither word nor glance."

For all the ferocity and pettiness of the rivalry between the chief participants, the 1977 prize for medicine marked an unparalleled chapter in the modern history of science—the search for substances that occur in such vanishingly small quantities that there were repeated suspicions and taunts that they did not even exist. The protagonists' goal was to locate the (initially hypothetical) proteins that were produced in the midbrain and travelled to the pituitary to determine the exact quantities of various hypophyseal hormones produced at any one time. Each began with five million tissue fragments taken from the midbrain of sheep and pigs—half a ton of the stuff—and each eventually came up with one milligram of the purified factor.

This scientific success story was keenly affected by the personal tensions that existed between the central characters and became particularly fierce after Schally went to run his own laboratory in New Orleans following five years with Guillemin in Houston. It was, for example, Schally's inferiority complex towards Guillemin as a physiologist that led him to recruit too many physiologists into his team, when he should really have put more money into chemistry. Then there is the question, somewhat puzzling from a purely technical standpoint, of why Schally chose to conduct his experiments with pigs. His explanation has all to do with competitiveness and little to do with science: "Because Guillemin was working with sheep, I had to accept as a theoretical possibility that he would come up with a hormone first, and if I were working on sheep too my contribution would be worthless."

Notwithstanding the bitterness, you have to admire the relentless persistence that drove a French doctor and a Polish war refugee onwards for two decades, through one mutual blunder that cost them three years' work, past a point around 1966 when their mission lost virtually all credibility with other investigators, and onwards to Stockholm. To add to this saga of determination and technical skill, the race was so uncannily close that it ended with the rival teams announcing the structure of thyrotrophin releasing factor within six days of each other in the autumn of 1969. It's a story as thrilling as that of a golf tournament between unrelenting opponents, decided by a single stroke on the 18th green on the final day.—

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