# Modeling and estimation of the number of individuals exercising their profession in several establishments: the case of anesthesiologists in France

N. Brouard          S. Pontone          Ph. Scherpereel

June 16, 2005

## Abstract

Reliable data on the number of medical doctors practicing in a country such as France cannot be obtained from national professional or administrative files because of the difficulties inherent to keeping them up to date. From a public health standpoint, the number of doctor positions in establishments matters more than the number of doctors, although the latter is nevertheless indispensable for demographic projections and to determine training needs. Shared work in the same position is sometimes encouraged in order to avoid closure of the position or even of the establishment. The relationship between the number of positions in a profession and the number of individuals working in those positions is complex and an original model of it has been developed. The model applied to a count of anesthesiologist positions in France and made it possible to estimate the number of these doctors, which has prove to be lower than the number of positions.

# 1 Shortage of Physicians in Western Countries? Shortage of Anaesthesiologists

The adequacy between the workforce of physicians and the needs of the population is a major Public Health question in many countries and many specialties. Estimating and forecasting needs is a complex matter highly debated.

Shortage of manpower among physicians is a redundant question in most developed countries since the mid 90's when increase in health expenses were related to the increasing number of physicians [Cooper, 2004]. Anaesthesiology, the most numerous specialty after surgery, was a new discipline and and the number of anaesthesiologists grew at a high speed since the late 60's. Shortage of Anaesthesiologists was a common feeling

among practitioners and first demographical projections proving the fortcoming shortage were published in France in 1991 [Pontone et al., 1991] and the question of the Anaesthesiological manpower gained Europe in 1996 [Rolly et al., 1996, Pontone and Brouard, 2001].

The purpose of this communication is not to enter the debate of the anaesthesiology disciplime in France and if other alternatives like a greater implication of nurse anesthetists like in Belgium [Demeere, 2002] are valuable, but to answer the basic question on how to count the number of Anaesthesiologists and Intense Care practitioners in France.

After describing the various sources of information like the professional registers we will explain why the French Society of Anesthesia and Intensive Care and the French College of Anaesthesiologist conducted an innovative project with the help of INED by trying to directly distribute a short questionnaire in any of the 1500 hospitals delivering anesthesia at the attention of all the Anaesthesiologists and Intensive Care practitioners.

The main problem of this survey was the multisite activity which makes the number of posts in hospitals differing from the number of workers.

Thus, we will focus on a model which describes the multisite activity as a variable increasing with the duration of the reference period.

## 2 Professional Registers

In order to count the number of physicians practising in France either as a general practitioner or as a specialist, we can have access to three different sources of data, the register of the Medical Council, the register of the Ministry of Health (ADELI register) and the register of the Social Security. Let us briefly describe them.

### 2.1 Register of the Medical Council

Even if the history of the Medical Council started during the French Revolution where corporations were abolished, the fight against charlatanism in 1791 was concomitant with the first improvements in surgery during the Napoleon's battles. If Napoleon created the Lawyers Council, he postponed the creation of a Medical Council because medical progresses were insignificant for him.

The current Medical Council, created by Charles de Gaulle in 1945, elaborated a deontological code. After 1968, the emergence of Medical Unions reinforces the deontological role of the Council. In 1971, the French government imposed a quota (numerus clausus) to enter the second year of medical studies. The aim of this adjustable quota, published every year, was mostly to regulate the demand of health services via the supply of a limited number of physicians in activity. In addition to this global regulation of physicians, specialization was restricted by a second quota/selection via a competition

at the end of the 6th year. Therefore, 4 to 5 additional years were then necessary to obtain a diploma in one of 37 medical specialities. Non specialists were trained during two additional years only in order to get the diploma of doctor in medicine. But in 2004, it was decided to equalize the duration of the training to 5 years, thus reducing the gap between the status of specialists and "family doctors".

In order to practice medicine, a physician must register each year to the medical council of his department. Therefore, this register is in an important source for an updated information on the profession, but it also includes retired people or physicians who swaped their medical activity to other interest like politics, journalism, research, etc. By registering to the medical council there are allowed to prescribe a drug to their family or relatives for example.

Since the mid 90's the demography of physicians gained interest. And the register improved in quality and specificity by distinguishing "physicians in activity" from others. In 2004 some variables concerning any registered physician (name, sex, specialty, professional address, phone, e-mail) are now freely accessible from the Internet, thus improving the quality of the register.

## 2.2 ADELI registers

Physicians, pharmacists, dental surgeons, midwives, nurses and other medical auxiliaries, social assistants, psychologists have to register in the region (French department) where they practice. Full name, date of birth, place of birth, nationality, private address, diploma, qualifications, sector practice (private or public) are recorded on an auto-administered questionnaire (http://www.sante.gouv.fr/cerfa/rubrique2.htm) which has to be dated and sent to the Direction Départementales des Affaires Sanitaires et Sociales in order to get a professional ID (Automatisation des listes, ADELI ID) which allows them to practice. If these registers are adequate to count new registrations, cancellation and modifications of the status are not systematically recorded because of the lack of adequate questions. If you move to a new region (department) or are practicing in a new hospital of a different region, you need to fill up a new questionnaire. But if your practice changes (new hospital, new sector practice) within the same region or stops (child bearing), changes will rarely be recorded even if they are encouraged.

## 2.3 Access to practitioners from the private sector via social security

Since 1999 with the *universal health coverage*, social security covers not only workers but any resident in France. Physicians (specialists or GP) from the private sector bill the social security for all their medical acts. Thus, identity and some other demographics data like age, sex, income, professional address

etc, of the physicians are recorded and updated regularly. But, this register does not concern physicians who are practising only in the public sector.

# 3 The model

Being aware of the difficulties to count the number of active physicians in France from the three current sources described earlier (8950 AICP were registered to the Medical Council in 1999, and 8483 [raw] to 10118 [after correction] were registered in the ADELI register in 1999), the French Society of Anesthesia and Intensive Care and the French Society of Anaesthesiologists decided to conduct a new project on collecting information on the Anaesthesiologists practicing in France using their own network of Anesthesia and Intensive Care practitioners (AICP).

This network of Anaesthesiologists had already proved its ability to perform in 1996 an important project on counting the "number of anesthesia" delivered during 3 following days in all public private and military hospitals in France. Most important result of INSERM (National Institute of Health and Medical Research) [Clergue et al., 1999] which collected and analyzed data, was an increase of 120% of anaesthetic procedures since 1980. But no information was asked on the number of AIC practitioners themselves.

In order to collect information on the demographics of Anaesthesiologists, they decided to cope with INED (French Institute on Demographic Studies) in 1998. The idea was to update the 1996 census of all hospitals and to take again contact with the former (or a new) volunteer which will manage the local survey among all AICP practicing during a week of reference in his hospitals.

The projects and their detailed results are published elsewhere [Pontone et al., 2004, Pontone et al., 2002] but what could be of interest here is to focus on the difference with an ordinary census and how modelling was necessary to compensate missing information.

## 3.1 Counting posts not individuals

The local referent, who was anaesthesiologist, received a fixed number of double A4 page questionnaires sent by regular post which he distributed to other Anaesthesiologists asking them to fill it during the week of reference.

If an Anaesthesiologist was practicing in 2 or more different hospitals during this reference period, he had to fill one full questionnaire (primary post) and 2 or more partial questionnaires in each other hospital (secondary posts). If he did not practice in any other hospital during this referenced week but during another week, he did not fill a supplementary questionnaire.

On the other side, if an hospital claims to practice anesthesia on a particular post but if their was no need for a AICP during this week or if they

could not find one, the post was 'vacant' and no anaesthesiologist could fill a questionnaire.

From this short explanation we can understand that there is no evidence for an adequacy between the number of posts for anaesthesiology and the number of anaesthesiologists.

We even did not know if the number of posts available was bigger or lower than the number of AICP.

In fact both situations may occur. In some hospitals we may have "nominative posts" who belong to precise AIC practitioners which are not visited each week (vacation, illness etc.) and in some hospitals "vacant posts" may be visited by one or more different AIC practitioners during a one week delay.

Also, longer is the duration of the reference period, more nominative posts will be visited by their owner and more replacement AICP will visit a vacant post. Even if the number of vacant posts could be precisely estimated, our method of survey allow us to consider a vacant post only if it has been visited during the reference period.

Thus, multisite activity depends on the time period. But which time period is most adequate for studying the multisite activity of Anaesthesiologists?

Our choice of a short period of one week was motivated mostly by practical considerations: we did not want that a too long period perturb the service (our model and its results are suggesting *a posteriori* that a two weeks interval would have been more informative).

But even during such a short period of a week, multisite activity level was $m_0 = 4.5\%$. It means that among all anaesthesiologists, 4.5% are working in one or more other places during the same week. What would this multisite activity level be if a two weeks interval? Probably about twice bigger. But what if the period lasts 3 weeks, a month or 6 months? A level off has to be expected.

In order to send adequate number of questionnaires to each hospitals, a first count of AICP in each hospitals by a regional coordinator (anaesthesiologist) who had in charge to contact the local referent or his/her secretary and ask for a precise number of AICP (excluding students). This first survey was checked again by INED, but INED's results were wrongly emphasized by double counting due to ignorance of local structure (multiple services in the same hospital etc.). During this first census by phone from the regional coordinator, no precise question was asked to the local referent but something like, how many AICP are *currently* working in the hospital. "Currently" does not provide a precise delay. If the question was how many AICP have been working in your hospital since 3 months or since 6 months, the total number will have increased, but how far? The total number of AICP declared by this phone survey (which was conducted during July to September 1998 before the real survey of 16-22 November 1998) was 9741 but it is more reflecting

a number of posts (some small hospitals are using replacement to perform anaesthesia) that a number of AIC practitioners and the reference period, named $t_D$, is unknown.

## 3.2 Questions on multisite activity

In order to measure multisite activity of AICP we asked two different questions, $C_1$: *Is your clinical activity on a single hospital? If no, in how many different hospitals?* and $C_3$: *Quote the type (public, private, military) and size of the different hospitals you are currently working for.* Mean number of additional hospitals were respectively, $m_1 = 16\%$ and $m_3 = 9\%$. It is clear that the implied reference period was longer for question $C_1$ that for question $C_3$. But unfortunately we did not precise a duration, like *since last two months* for $C_1$ and *since last two weeks* for question $C_3$.

Thus our main hypothesis is that our 3 multisite activity levels, $m_0$ for a week, $m_3$ for $t_3$ and $m_1$ for $t_1$ would have been coherent if $t_3$ and $t_1$ had be precised in the label of questions $C_3$ and $C_1$.

Our first effort consists in building a model of $m(t)$ which describes the level of multisite activity (activity in different hospitals) according to time delay $t$.

Our second effort will consist, by adding some minor hypotheses, in giving reasonable delays of $t_3$ and $t_1$ in order to justify a reasonable number, $N$, of active AICP in France corresponding to the 9741 posts (surveyed by phone over a $t_D$ period). This method allowed us to estimate precise regional estimates of the demographics of Anaesthesiologist and Intense Care practitioners by weighting our survey records for non-respondents.

## 3.3 Modelling time dependent multisite activity

In order to model time dependent multisite activity of Anaesthesiologists we consider three levels, hospitals ($H_i$), posts ($P_i$) and individuals ($I_i$). Figure 1 helps understanding the three levels and how links from individuals (AICP) are added to posts with time, i.e when a practitioner has been practising on a post during a reference period $t$.

A distinction is made between "permanent positions" or "named posts" which correspond to AICP who have their name recorded "permanently" for the post and "vacant posts" or "posts for replacement". If the majority of the AIC practitioners are working in a single hospital, some of them have additional named posts in other hospitals. By definition only the owner of the post can work on a named post.

### 3.3.1 Permanent posts model

We are supposing that during the week of reference, each AICP practising on a named post is at least visiting his *primary* post and have filled a full
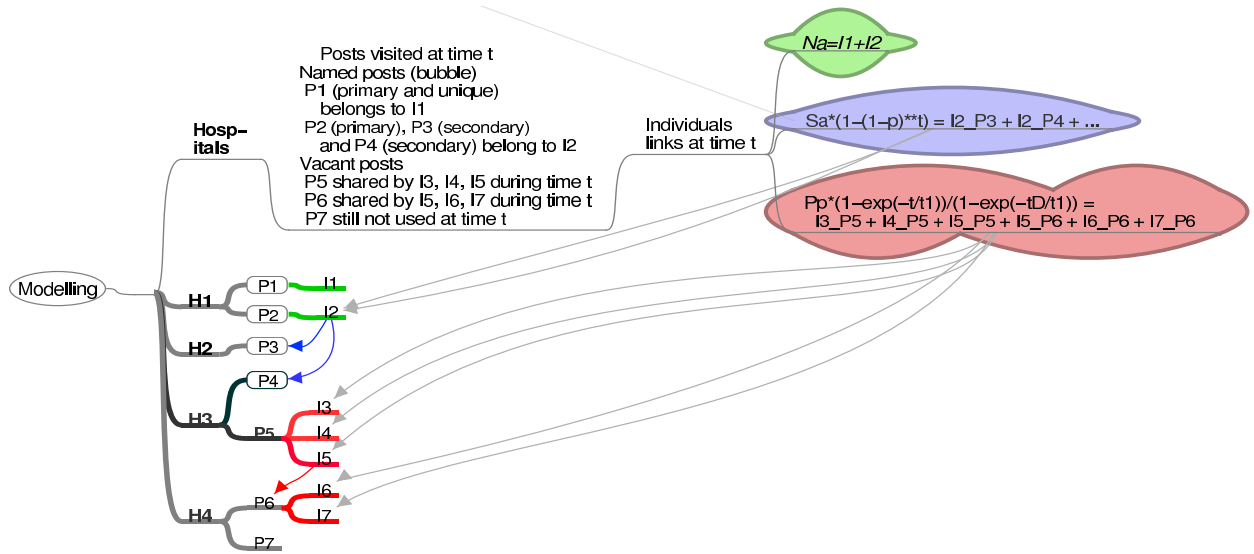
Posts visited at time t
Named posts (bubble)
 P1 (primary and unique)
  belongs to I1
 P2 (primary), P3 (secondary)
  and P4 (secondary) belong to I2
Vacant posts
 P5 shared by I3, I4, I5 during time t
 P6 shared by I5, I6, I7 during time t
 P7 still not used at time t

**Hosp‐
itals**

Individuals
links at time t

$Na = I1 + I2$

$Sa*(1-(1-p)**t) = I2\_P3 + I2\_P4 + ...$

$Pp*(1-exp(-t/t1))/(1-exp(-tD/t1)) =$
$I3\_P5 + I4\_P5 + I5\_P5 + I5\_P6 + I6\_P6 + I7\_P6$

Modelling

H1   P1   I1
     P2   I2
H2   P3
     P4
H3   P5   I3
          I4
          I5
H4   P6   I6
          I7
     P7

Figure 1: Modelling links from Individuals to Posts. The case of Anaesthesiol‐
ogy.

questionnaire. Otherwise he belongs to people in "vacations or sick".

Among practitioners having one or more secondary place of work, only a proportion $p$ will visit it during this first week simply because they do not work each week on this(these) secondary post(s). The frequency of $p$ can be typically 0.7 which means that a practitioner visits a secondary position 7 times in 10 weeks, or 0.5 which means visiting once every two weeks.

Thus, if $S_a$ is the total number of named positions, only $pS_a$ will be visited during the first week (and only $pS_a$ full questionnaires will be filled during this first week). Among the $S_a(1-p)$ posts not visited during the first week, $pS_a(1-p)$ will be visited during the second week etc. After time $t$ (expressed in weeks), $\alpha(t,p)$ secondary named posts will have been visited by their owners, with:

$$\alpha(t,p) = S_a(1 - (1-p)^t) \tag{1}$$

### 3.3.2 Vacant positions model

If during time $t$, some "vacant posts" will not be visited by any AIC practitioner, some others will. As time $t$ is increasing, less and less vacant posts will be really vacant and more and more replacement AIC practitioners will have worked on a common post.

Let us model this growth by an exponential model with a time constant and a magnitude. As we need to explain the increase of m(t) between $t_3$ ($m_3 = 0.09$) and $t_1$ ($m_1 = 0.16$) the time constant must be higher than $t_3$ and close to $t_1$. Without a huge loss of generality we can set the time constant to $t_1$.

For the magnitude, we can make the hypothesis the number of vacant posts corresponds to the number of replacement AIC practitioners after a period of $t_D$. This will *justify the confusion between posts and practitioners* during the phone survey.

Thus the number of practitioners sharing a vacant post after a delay $t$ can be stated as:

$$\beta(t, t_D, t_1) = \frac{1 - \exp(-t/t_1)}{1 - \exp(-t_D/t_1)} \,. \tag{2}$$

At last, we made the strong hypothesis that the unknown delay $t_3$ corresponds to the unknown delay $t_D$. It seemed reasonable to think that anaesthesiologists have the same perception of the delay required to measure the "current" situation, both for the regional coordinator responsible of the regional phone survey as for the AIC practitioner answering question $C_3$.

### 3.3.3 Scalability

We can make some easier assumptions concerning the scalability of the phenomena. Let us first propose that the number of *vacant posts* or *shared posts*,

$P_p$, is proportionate to the total number of anaesthesiologists, $N$, $P_p = p_p N$ as for the number of replacement AIC practitioners $N_r$ sharing those posts: $N_r = \gamma N$ (some are really vacant but some others are used by multiple practitioners).

Let us also suppose that the number of secondary named posts, $S_a$ is also proportionate to $N$, $S_a = s_a N$.

Thus, the number of different links from any anaesthesiologists $I$ to any post $P$ in a delay $t$ can be modelled as:

$$N_a + S_a \alpha(t,p) + P_p \beta(t, t_D, t_1) = N(1-\gamma) + N s_a \alpha(t,p) + N p_p \beta(t, t_D, t_1) \tag{3}$$

And the mean number of additional links (multisite activity), $m(t)$ is a function of $t$ and of 6 unknown parameters, $\gamma$, $p$, $t_D = t_3$, $t_1$, $s_a$ and $p_p$:

$$m(t) = -\gamma + s_a \alpha(t,p) + p_p \beta(t, t_D, t_1) \tag{4}$$

m(t) is known at three specific times, 1 week, $t_3 = t_D$ and $t_1$:

$$m(1) = m_0 = -\gamma + s_a p + p_p \beta(1, t_3, t_1) \tag{5}$$
$$m(t_3) = m_3 = -\gamma + s_a \alpha(t_3, p) + p_p \tag{6}$$
$$m(t_1) = m_1 = -\gamma + s_a \alpha(t_1, p) + p_p \beta(t_1, t_3, t_1) \tag{7}$$

We have 6 parameters and 3 equations. Let us make some scenarios by fixing arbitrarily $p$, $t_3$ and $\gamma$ and let us deduce other parameters, $t_1$, $s_a$ and $p_p$. For example, we can solve first and second equations in $s_a$ and $p_p$ (two crossing lines) and get a solution depending of $t_1$. When $t_1$ varies we get a curve solution of first two equations. We can also do the same thing with second and third equation and find another curve. Both parametric curves are crossing in one point which corresponds to the unknown time $t_1$.

### 3.3.4 Some solutions

We started with case A where $p = 7$ times in 10 weeks (0.7), $t_3$=2.5 weeks and $\gamma$=0.011 (in order to get about 100 replacement AIC practitioners) and computed $t_1$ as being 6.635 weeks. A reference period of 6.6 weeks looked very satisfactorily for the implicit delay of question $C_1$.

$m(t)$ and its decomposition into $-\gamma$, $s_a \alpha(t,p)$ and $p_p \beta(t, t_1, t_3)$ are represented on Figure 2.

Figure 3 gives another solution (Case B) for a much smaller frequentation of secondary permanent posts ($p = 0.5$, a double number of replacement practitioners ($\gamma = 0.022$) and a shorter time $t_3 = t_D = 2.1$ weeks which leads to $t_1 = 5.6$ weeks.

We can verify on both figures that $m(t)$ corresponds to value of $m_0 = 4.5\%$ at 1 week, $m_3$ =9% at $t_3$ weeks and $m_1$ =16% at $t_1$ weeks.
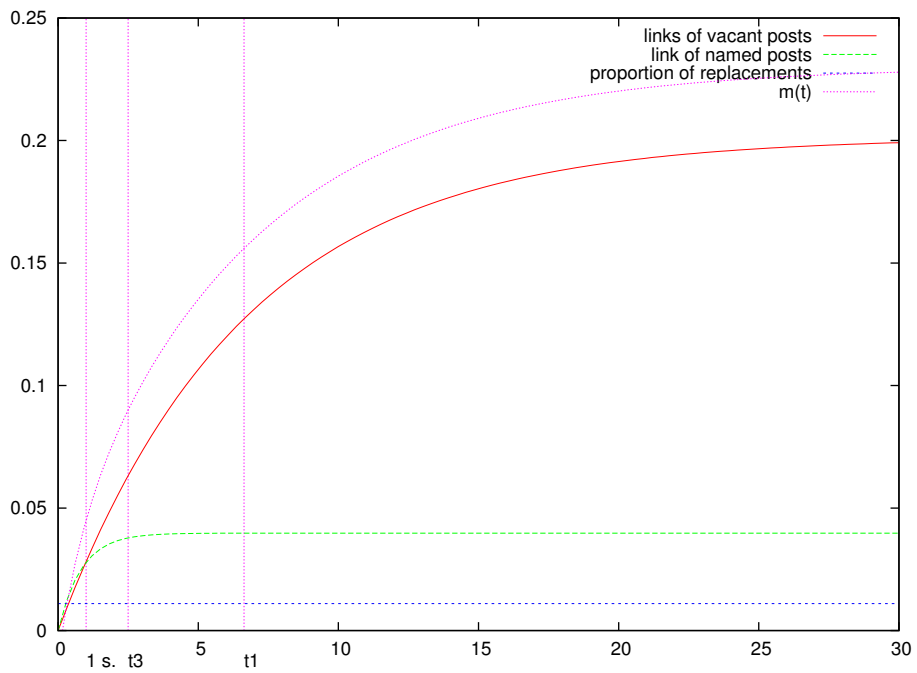
Figure 2: Multisite activity according to the period of reference. Case A ($p = 0.7$, $t_3 = 2.5$, $\gamma = 0.011$, $t_1 = 6.6$).
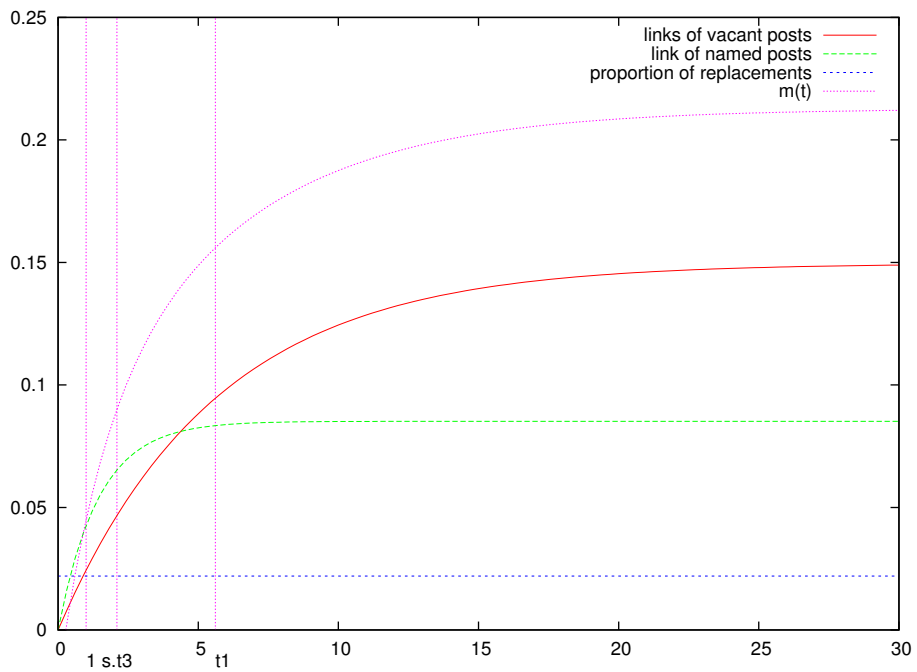


Figure 3: Multisite activity according to the period of reference. Case B ($p = 0.5$, $t_3 = 2.1$, $\gamma = 0.022$, $t_1 = 5.6$)

### 3.4 Deducing the number of AIC practitioners from the number of posts

The total number of posts which could be visited during a delay $t_D$ is equal to the number of primary named posts $Na$, plus the number of secondary named posts $S_a(1 - (1 - p)^t_D)$, plus the number of vacant posts which is, by hypothesis $(\beta(t_D, t_1, t_D) = 1)$, simply $Np_p$.

To be more complete we must add the posts of AIC practitioners who were in "vacation or sick" during the corresponding period. This number was $96/7439$ $N = iN$. We made the assumption that they were replaced by colleagues of the same hospital (i.e. they did not interfere with vacant posts).

Thus, the time dependent total number of posts $P(t_D)$ is related to the fixed total number of Anaesthesiologists, $N$, by the following equation:

$$P(t) = N \left(1 - \gamma + s_a(1 - (1 - p)^t) + p_p \frac{1 - \exp(-t/t_1)}{1 - \exp(-t_D/t_1)} + i \right) \quad (8)$$

If our hypothesis that the implicit duration $t_3$ of question C3 is equal to the implicit delay during the phone survey, $t_D$, is valid, the equation simplifies to a simple relation between the number of posts $P$ and the number of AIC practitioners $N$ involving only $m_3$ and $i$:

$$P(t_3) = N \left(1 - \gamma + s_a(1 - (1 - p)^{t_3} + p_p + i \right) \quad (9)$$
$$P = P(t_3) = N(1 + m_3 + i) \quad (10)$$

But the validity of this equation depends on the validity of the model and of our hypotheses.

### 3.5 Validity of the model and hypotheses

In order to test the validity of the model and its hypotheses we used some of the solutions already presented in a previous section (cases A and B) and examined the shape of the total number of posts, $P(t)$ according to the duration of the reference period. Case A (figure 4) looks good because the number of posts, 9741, observed at $t_3 = t_D = 2.5$ weeks is close to the plateau.

This justifies the fact that the common sense of "current" situation is rapidly obtained after 2.5 weeks.

But in Case B on Fig.5, the number of posts, $P(t)$, continues to raise after $t_3 = 2.1$ weeks, and reaches a plateau of 9950 only after 7 weeks: this looks unrealistic.

Case A is not unique and other solutions are valuable too. Case C is obtained with same $p = 0.7$ and $t_3 = 2.5$ values as case A, with the same amount of replacement AIC practitioners as in case B ($\gamma = 0.022$) which leads to a longer time $t_1$ of 7.385 weeks still plausible.
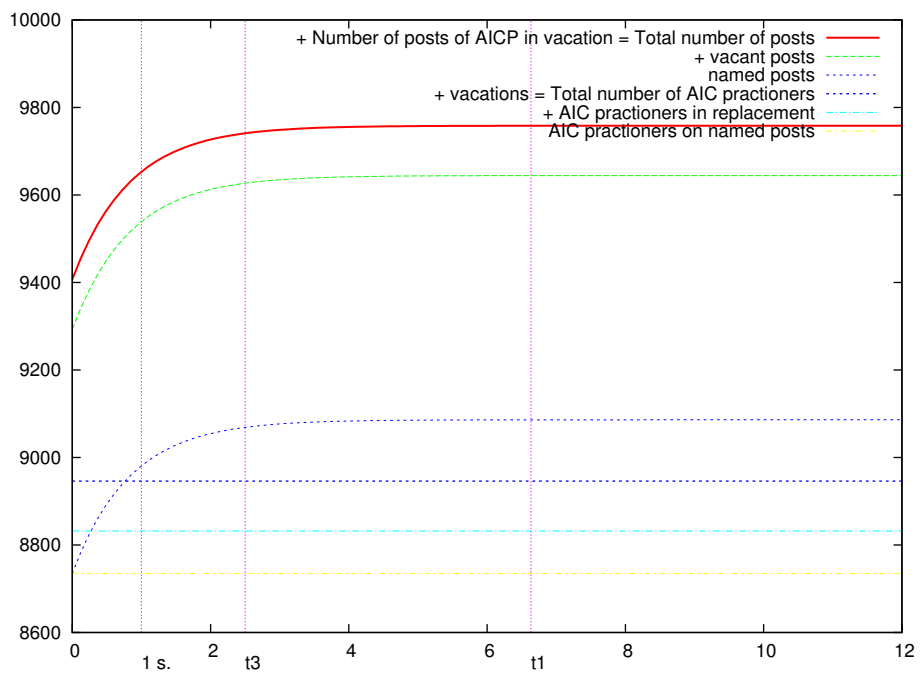
Figure 4: Number of named posts, vacant posts, posts of people in vacation or sick and total number according to the length of the reference period. Number of permanent and replacement AIC practitioners. Plausible case A.
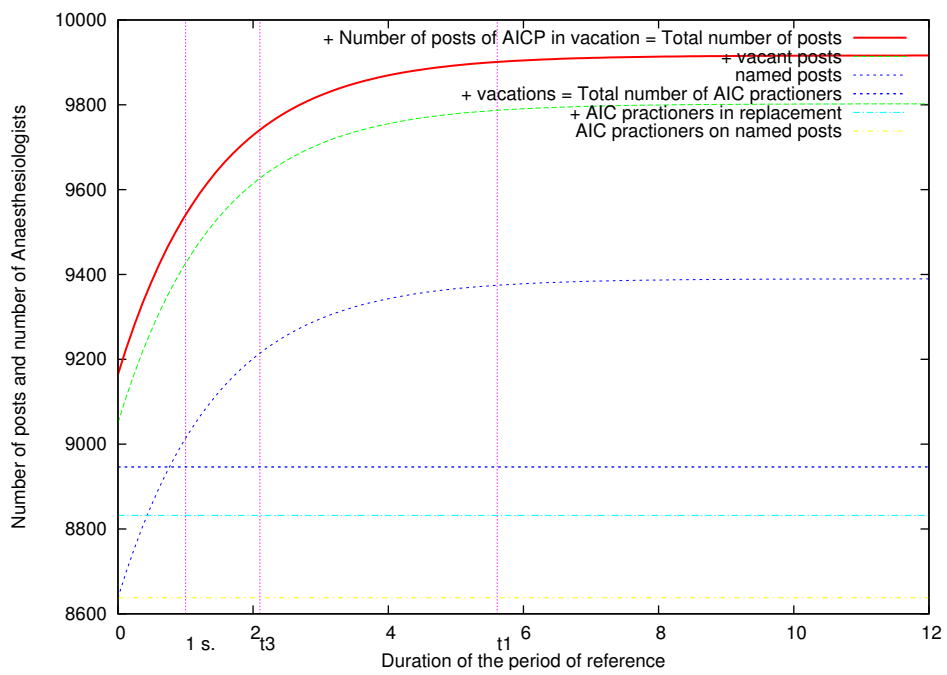
Figure 5: Number of named posts, vacant posts, posts of people in vacation or sick and total number according to the length of the reference period. Number of permanent and replacement AIC practitioners. Non plausible case B.

The existence of cases like case A and C comfort us in the validity of both the model and the idea that a census should be independent of the duration of the observation period.

The strongest assumption of our model concerns the fact that $t_3$ and $t_D$ should be identical in order to get equation 10. Let us assume that one the valuable case, like case A or C (with a quick plateau after time $t_D$, is true and let us suppose that the implicit reference period of question $C_3$ was not equal to $t_D$=2.5 weeks but to a 1 week or, on the opposite, to 6 weeks, then the number of AIC posts or practitioners will vary only of about 100 cases (Fig.4).

This relation 10 was the key for further statistical analyses of the survey by allowing us to post stratify our sample of respondents (non response and refusal rates varied from 1.8% to 26.6 in some regions).

We simply used regional values of the regional multisite activity given at question $C_3$, $m_{3r}$, in order to deduce from the regional survey on the number of posts $P_r$, the number of AIC practitioners working in the region, $N_r$ using equation (we assumed that inter regional activity was rare and that the perception of $t_3$ and $t_D$ was identical among all regions):

$$P_r = N_r(1 + m_{3r} + i_r) \tag{11}$$

Each record of the $N_{or}$ full questionnaires of a region $r$ were then weighted by

$$w_r = N_r/N_{or} \, . \tag{12}$$

# 4 Conclusion

Despite missing precision on the period of reference in the labelling of questions concerning multiple site activity of our survey on AIC practitioners, we have been able by modelling the growth of multisite activity with time, to deduce an important relation between the number of posts surveyed during a phone survey and the number of Anaesthesiologists and Intense Care practitioners both at the national (9741 vs 8992) and regional levels.

In order to measure multiple activities in professions similar to Anaesthesiologists, our current recommendations concern the necessity of inclusion in the label of the question on multisite activity at least three to four periods of reference. For example the question could ask for the number of different places of work during last week, 3 weeks, 2 months and 6 months.

If our survey methodology was reproduced, i.e autoadministered questionnaire delivered to all professionals of an etablishment, the duration of the survey should officially last longer that a week and at least two weeks in order for professionals having different places of work to have more chances to be counted twice or more times.

A model, similar to the model presented here, should then be able to make all the data on multisite activities globally coherent.

Even if our survey methodology and our questionnaire concerning multisite activity were not optimal, the main result of our model was that the number of AIC practitioners (less than 9000) was lower than the number of posts (9741), contributed to the more general debate in France on the shortage of manpower in certain specialties of medicine.

The nice consequence of the debate was an increase of the numerus clausus which raised from 3700 in 1998 to 6200 in 2005.

# References

[Clergue et al., 1999] Clergue, F., Auroy, Y., Péquignot, F., Jougla, E., Lienhart, A., and Laxenaire, M. (1999). French survey of anesthesia in 1996. *Anesthesiology*, 91(5):1509–20.

[Cooper, 2004] Cooper, R. A. (2004). Scarce physicians encounter scarce foundations: a call for action. *Health Aff (Millwood)*, 23(6):243–9.

[Demeere, 2002] Demeere, J. (2002). Anaesthesia manpower in Belgium until 2020: nurse anaesthetists–a possible solution? *Eur J Anaesthesiol*, 19(10):755–9.

[Desmonts et al., 1991] Desmonts, J., Pontone, S., Brouard, N., and Moulin, J. (1991). Vers un manque d'anesthésistes-réanimateurs en France : de combien et quand ? In *33e congrès national d'anesthésie-réanimation, 20-22 septembre 1991*. Société française d'anesthésie et de réanimation, Masson. Communication R7.

[Pontone and Brouard, 2001] Pontone, S. and Brouard, N. (2001). Facteurs influençant les besoins en médecins : un éclairage par spécialité. l'anesthésie réanimation. In *Démographie médicale. Peut-on évaluer les besoins en médecinsă?*, pages 85–96, Paris. CREDES. Actes du séminaire du 11 octobre 2000 organisé par le Conseil Scientifique de la CNAMTS et le CREDES.

[Pontone et al., 1991] Pontone, S., Brouard, N., Moulin, J., and Desmonts, J. (1991). Vers un manque d'anesthésistes-réanimateurs en France : de combien et quand ? *Ann FR Anesth Réanim.*, 10:362–378.

[Pontone et al., 2002] Pontone, S., Brouard, N., Scherpereel, P., Boulard, and G., Arduin, P. (2002). Les médecins anesthésistes réanimateurs en france en 1999. premiers résultats de l'enquête démographique nationale cfar - sfar - ined. *Ann. Fr. Anesth. Réanim.*, 21(10):779–806.

[Pontone et al., 2004] Pontone, S., Brouard, N., Scherpereel, P., Boulardl, G., Arduin, P., and Group, C.-S.-I. W. (2004). Demography of French anaesthesiologists. Results of a national survey by the French College of Anaesthesiologists (CFAR) and the French National Society of Anaesthesia and Intensive Care (SFAR), supported by the National Institute for Demographic Studies (INED). *Eur J Anaesthesiol*, 21(5):398–407.

[Rolly et al., 1996] Rolly, G., MacRae, W., Blunnie, W., Dupont, M., and Scherpereel, P. (1996). Anaesthesiological manpower in Europe. *Eur J Anaesthesiol*, 13(4):325–32.