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Julien Mousquès (Irdes, Prospere)
Yann Bourgueil (Irdes, Prospere)
Philippe Le Fur (Irdes, Prospere)
Engin Yilmaz (Drees)

DT n° 29

January 2010

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IRDES

Institut de recherche et documentation en économie de la santé
10, rue Vauvenargues 75018 Paris
www.irdes.fr • Tél: 01 53 93 43 02 • Fax: 01 53 93 43 07 • E-mail: publications@irdes.fr

- Director of publication: Caherine Sermet
- Scientific adviser: Thierry Debrand
- Copy editing: Franck-Séverin Clérembault - Anne Evans
- Layout compositor: Khadidja Ben Larbi
- Distribution: Suzanne Chriqui, Sandrine Bequignon

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Effect of a French Experiment of Team Work between General Practitioners and Nurses on Efficacy and Cost of Type 2 Diabetes Patients Care

Julien Mousquès[a,b*], Yann Bourgueil[a,b], Philippe Le Fur[a,b], Engin. Yilmaz[c]

Abstract

This study aims to assess the efficacy and the cost of a French team work experiment between nurses and GPs for the managing of type 2 diabetes patients. Our study was based on a case control study design in which we compare the evolution of process (standard follow-up procedures) and final outcomes (glycemic control), and the evolution of cost. The study is realized for two consecutive periods between type 2 diabetes patients followed within the team work experiment (intervention group) or by "standard" GPs (controlled group).

After 11 months of follow-up, we showed that patients in the intervention group, compared with those in the controlled group, have more chances to remain or to become: correctly followed-up (with OR comprise between 2.1 to 6.8, p<=5%) and under glycemic control (with OR comprise between 1.8 to 2.7, p<=5%). The latter result is obtained only when a visit for education and counselling has been delivered by a nurse in supplement to systematic electronic patient registry and electronic clinical GPs reminder. All these results are obtained without difference in costs between the intervention and the controlled groups.

Finally, this experimentation of team working can be considered both effective and efficient. Our findings may have implications in the design of future larger primary care team work experiments to be launched by French health authorities.

Keywords: Primary health care, Diabetes mellitus, Health care team, Comparative study, Outcome and process assessment, Cost analysis.

Classification/JEL Codes: I12

[a] Institute for research and information in health economics (IRDES), Paris.

[b] Interdisciplinary Partnership for Research on the Organisation of Primary Care (PROSPERE), Paris.

[c] Ministry of Health' Directorate for Research, Analysis, Evaluation and Statistics (DREES).

[*] Corresponding author. IRDES, 10 rue Vauvenargues, 75018 Paris, France.
Tel.:+33 153934362; fax: +33 153934350. E-mail address: mousques@irdes.fr

Résumé

Cette étude a pour objectif d'évaluer l'efficacité et les coûts d'une expérimentation de travail en équipe entre des infirmières et des généralistes (l'expérimentation Action Santé Libérale En Equipe (ASALEE)), dans le cas de la prise en charge des patients souffrant de diabète de type 2.

Elle s'appuie sur un *design* cas/témoin dans lequel nous comparons l'évolution des résultats de soins en termes de processus (procédures standards de suivi) et de résultat final (le contrôle glycémique), ainsi qu'en termes de coûts. Cette comparaison est réalisée entre deux périodes consécutives et entre des patients diabétiques de type 2 suivis dans l'expérimentation (le groupe d'intervention) ou dans le groupe témoin (le groupe contrôle).

Nous montrons qu'après onze mois de suivi, les patients ASALEE, comparés à ceux du groupe témoin, ont une plus grande probabilité de rester ou devenir bien suivis en termes d'indicateurs de processus (OR compris entre 2.1 à 6.8, $p < 5$ %), ainsi qu'en termes de contrôle glycémique (OR compris entre 1.8 à 2.7, $p < 5$ %). Ces derniers résultats sont obtenus uniquement lorsque les patients ont bénéficié d'au moins une consultation infirmière d'éducation et de conseils hygiéno-diététiques en complément du rôle classique des infirmières dans le cadre de l'expérimentation ASALEE, c'est-à-dire la mise à jour des dossiers médicaux informatisés avec l'inscription éventuelle de rappels informatiques à destination des généralistes.

Mots-clefs : soins primaires, diabète de type 2, travail en équipe, étude comparative, évaluation des résultats et des processus, analyse de coût.

1. Introduction

The improvement of the quality of care delivered by health professionals and the strengthening of primary care organization are seen as two key elements for increasing the performance of health care systems in a context of increasing demand and constraints in resources [1-6]. Thus, numerous countries have undertaken reforms that aim at improving medical practices or organizing in a different way the provision of primary or ambulatory care and services, especially for chronic patients. This requires the production of medical practice guidelines and the implementation of "evidence based medicine" in daily practice through policy intervention close to doctors and the implementation of primary care and services organisational innovations: chronic care and/or disease management, performance based economic incentives, group practice and team work [7].

Numerous systematic literature reviews are henceforth available [8-15]. Passive intervention policy, which includes the simple provision of educational material and standard education activities (*e.g.* conferences, congresses,...) are considered to be little effective. On the contrary, more active policy interventions have proved to be more effective. These include more advanced continuing medical education strategies (*e.g.* academic detailing); therapeutic information systems, audit and feedback as well as electronic reminders; and finally, all "organisational-oriented" policies. Within the latter, our concern is specifically about policies focused on teamwork and cooperation between GPs and nurses, when nurses substitute or supplement physician workforce. Most of the studies converge in their conclusions: nurses adequately trained for specific actions (*e.g.* prevention, first contact, follow-up of a chronic patient…) can deliver care and services at least from a same level of outcome in terms of quality – indeed superior when the nurse act in complement – and with a greater level of outcome in terms of satisfaction, than of primary care doctors [10,16,17]. The magnitude of cost saving and of efficiency gains depends on salary and productivity differentials between nurses and GPs, and possible duplication.

In France, in spite of a public debate on the levers for performance improvement at the professional or organisational levels [18-22], the recent reforms conserve an "embryonic character". Our health system still combines a relative free and comprehensive access to care and services for insured [23,24], with a weak regulation both of professional practices and ambulatory care organisations. One can observe that the French health care system has a fragmented ambulatory care system, more than a formal primary care organisation. Most of ambulatory care professionals are self-employed and work in solo practice paid on a fee-for-service basis. They are historically not subject to constraint by any strict mandatory quality regulation, and only recently both continuing medical education and the evaluation of professional practice have become mandatory.

As a consequence, several signs of inefficiency in health care delivery have come to light; especially for chronically ill patients for whom there has been no dramatic improvement in the care delivery – *e.g.* for diabetes patients [25-29] – despite their growing place in the burden of disease and the fact that they currently consume an increasing share of the French health care system's resources [30,31].

After all, some experiments of networks, GP group practices, skill mix and teamwork (*e.g.* between GPs and nurses), are supported by an increasing number of stakeholders (sickness funds, state and local representatives…) and professionals' representatives [32, 33]. A national policy experiment in cooperation and skill mix was carried out between 2004 and 2008 [33,34]. This policy authorized ten experiments which involved mainly the transfer of: technical procedures, follow-up of chronic patients with hepatitis, prevention. Only two of them are related to ambulatory care, and one to general practice: the ASALEE experiment (*Action de Santé Libérale en Equipe*[1]).

Our general objective is to assess the efficacy and the cost of the ASALEE experiment regarding the management of type 2 diabetes patients, defined by the fact that they are treated by at least one oral anti-diabetic medication, which represents the bulk of the nurse working time[2]. The ASALEE experiment began in 2004 with 3 practices clustering 12 GPs and 3 nurses. In 2007, 18 practices

[1] Health Action by Teams of Self-employed Health Professionals.

[2] Nurses are also involve in: counseling for high blood pressure, screening for cognitive problems and cardiovascular risk factors in individuals over 75 years old, screening campaigns (breast cancer, cervix cancer, cognitive disorder).

involving 41 GPs and 8 nurses participated in the experiment. All the GPs and nurses remained in the experiment from the beginning.

Our specific objectives are: first, to assess the efficacy both regarding process (adequacy of follow-up procedures) and final (glycemic control) outcomes; second, to assess the difference of impact between two levels of nurse intervention in supplement to the GP: systematic electronic patient registry and electronic clinical reminder (level 1) combine or not with patient education and counselling (level 2); third, to assess the impact on direct costs for the National Health Insurance Funds, including additional cost generated by ASALEE experiment (i.e. nurses' wages,...).

2. Materials and methods

For type 2 diabetes patients, the activity provided by the nurses complements the GPs' at two levels. The first level (level 1) of intervention by the nurses is a systematic electronic patient registry of type 2 diabetes patients. This list was based on of the GPs' electronic patient records. For all these patients, the nurses log specific information (mainly requested biological results for the follow up). If require, the nurses can introduce electronic reminders inside electronic patient records. These electronic reminders alert the GP, during the patient's visit, the examinations to be conducted according to the national guidelines. The second level of intervention (level 2) is patient education and counselling in order to give nutritional-hygienic and treatment compliance advices. They are performed by nurses after a referral from the GP and are conditioned by an agreement from the patient.

Our evaluation design was constituted by three distinctive case control studies which compare the evolution of three dimensions of results between two consecutive periods between the intervention (ASALEE experiment) and the controlled groups (IGs *vs.* CGs). For the latter no nurses' assistance in their practice was developed. The three domains assessed were: efficacy regarding process outcomes, efficacy regarding final outcome, costs. Then, IGs cases were based on three subsamples of type 2 diabetes patients followed by GPs and nurses of the ASALEE experiment – depending on the level of nurses intervention they had benefitted – between June 2004 and May 2007 and still followed in May 2007 (intention to treat study). These three IG subsamples were compared, *a posteriori*, with those of three CGs. It should be noted that controlled group samples was matched to intervention group samples at baseline, with at least an equivalent distribution in terms of age and gender. Table 1 gives the distribution of all the variables for IGs compared with the distribution in the CGs; we could observe that characteristics of type 2 diabetes patients in the IGs and in the CGs are similar.

Table1 - Descriptive statistics for ASALEE experiment (intervention group) samples

	Eligible Population		Study population regarding the nature of the assessment					
			Efficacy according to the intermediate outcome measure (glycemic control)		Efficacy according to the process outcomes measures (follow-up procedures)		Cost	
	n	%	n	%	n	%	n	%
Gender								
Woman	704	41.81	254	43.2	362	43.2	347	43.65
Men	980	58.19	334	56.8	476	56.8	448	56.35
Age*								
< 50 years	129	7.66	22	3.74	72	8.59	63	7.92
50-60 years	315	18.71	103	17.52	172	20.53	166	20.88
60-70 years	438	26.01	148	25.17	218	26.01	203	25.53
70-80 years	552	32.78	202	34.35	286	34.13	274	34.47
>= 80 years	250	14.85	113	19.22	90	10.74	89	11.19
Age*								
< 65 years	659	39.13	198	33.67	-		-	
>= 65 years	1 025	60.87	390	66.33	-		-	
Type of follow-up by Public Health Nurse since								
Data management (+/- electronic reminder)	987	58.61	304	51.7	435	51.91	409	51.45
Data management (+/-electronic reminder) and visit for education and counselling	697	41.39	284	48.3	403	48.09	386	48.55
Location within the Deux-Sèvres department								
North	-	-	-	-	229	27.33	218	27.42
South	-	-	-	-	609	72.67	577	72.58
Type of Mandatory Social Security Funds								
National Health Insurance Fund for salaried salaried employees	-	-	-	-	611	72.91	572	71.95
National Health Insurance Fund for farmers workers	-	-	-	-	227	27.09	223	28.05
Waves of inclusion (in 4 classes)**								
June 2004 to March 2005	348	20.67	-	-	188	22.43	185	23.27
April 2005 to January 2006	255	15.14	-	-	122	14.56	115	14.47
February 2006 to June 2006	302	17.93	-	-	146	17.42	139	17.48
July 2006 to May 2007	779	46.26	-	-	382	45.58	356	44.78
Waves of inclusion (in 3 classes)**								
June to December 2004	-	-	184	31.29	-	-	-	-
February to July 2005	-	-	171	29.08	-	-	-	-
January to June 2006	-	-	233	39.63	-	-	-	-
Total	1 684	100	588	100	838	100	795	100

* Due to technical consideration number of age classes were dependent on the nature of assessment

** Due to technical consideration number of waves classes were dependent on the nature of assessment

The first efficacy evaluation was based on the analysis of the evolution between two consecutive periods – between July 2005-June 2006 (t-1) and between July 2006-June 2007 (t) –, of process outcome measures, which corresponds to the probabilities of becoming or still be adequately followed-up, over one year, for six standard follow-up procedures recommended by the French National Authority in Health guidelines. According to these guidelines, the rate of HbA1c of patients suffering from diabetes must be controlled at least three times a year and they must also be subjected to a biological examination every year (creatinemia, microalbuminuria, lipid check-up), to an electrocardiogram or to a consultation with a cardiologist, and funduscopy. 838 type 2 diabetes patients in the intervention group were compared with those of 1018 type 2 diabetes patients in the controlled group (*i.e.* followed by standard GPs, without any nurse intervention in their practice). The ASALEE experiment is considered efficient if the proportion of patients that become or still be adequately followed-up over one year is greater than in the controlled group. We particularly look at the difference of impact between the two levels of nurse's intervention within the ASALEE experiment.

We have used logistic regressions to model probabilities of becoming or still be followed correctly over one year for the six procedures (HbA1c, microalbuminuria, funduscopy, creatinemia, electrocardiogram, lipid check-up) and between the CG and the IG. For the patient in the latter we take in consideration whether or not the participants have had nurse visits for education and counselling. The results were controlled by: age (less than 49, from 50 to 59, from 60 to 69, from 70 to 79, over 80), gender (female or male), location within the *Deux-Sèvres* department (north, south), type of Mandatory Social Security Funds (salaried employees, farmer workers), the presence or not of medicated treatments indicating lipid problems and/or diabetes complications, the type of medicine treatment for diabetes (one oral antidiabetic drug, the association of two oral antidiabetic drugs, the association of oral antidiabetic drug and insulin).

The second efficacy evaluation was based on the analysis of the evolution over one year of the efficacy through final outcomes: the probabilities, before and after the intervention, of maintaining one's glycosylated haemoglobin[3] (HbA1c) or reducing it to a level below or equal to three different thresholds: 6.5%, 7%, 8%. Measuring HbA1c before and after the intervention of the nurses was performed for 588 patients of the ASALEE experiment. The evolution of HbA1c was compared to that of a control group of 202 type 2 diabetes patients followed by a panel of standard GPs (with no nurses intervention in their practices)[4]. The ASALEE experiment is considered efficient if the proportion of patients under glycemic control improve, over one year, greater than in the controlled group. We particularly look at the difference of impact between the two levels of nurse's intervention within the ASALEE experiment.

We used logistic regressions to model probabilities of maintaining or reducing HbA1c, before-and-after the intervention, regarding the three different thresholds of glycemic control and between the CG and the IG. For the latter we take in consideration whether or not the patients have had nurse visits for education and counselling. The results were controlled by: age (under 65, over 65), gender (woman versus man), the HbA1c status (value at baseline, number of HbA1c tests performed in the year following inclusion, number of months separating the measurements before-and-after) and seasonality (waves of inclusion: June 2004 to March 2005, April 2005 to January 2006, February 2006 to June 2006, July 2006 to May 2007).

Finally, the cost evaluation concerns the analysis of the evolution between two consecutive years – between July 2005-June 2006 period (t-1) and between July 2006-June 2007 period (t) – of the type 2 diabetes direct costs for National Health Insurance Funds both for the IG and for the CG. The costs analyses were based on claims data and we distinguished the total expenditure for all procedures – *i.e.* all the direct cost for type 2 diabetes patients (hospital and ambulatory care procedures where include) reimbursed by the National Health Insurance Funds – and total expenditure specific to type 2 diabetes. These latter included all the direct costs allocated to diabetes by using the coding of medical procedures and services stemming from claims data: all the expenses of following up diabetes, including those related to the risk factors of diabetes (e.g. visits or treatment for smoking cessation) and its complications (*e.g.* treatment for ischemic cardiopathy).

The evolution of theses costs were compared between the IG, 795 type 2 diabetes patients, and the CG, 956 type 2 diabetes patients followed by "standard" GPs (with no NURSES intervention in their practice). It should be noted first that the cost for ASALEE patients is increased by the expenses specific to the experiment (nurses' salaries, training expenses, etc.), *i.e.* €60/yr per patient.

We used a linear regression model in order to compute total and specific to diabetes costs in *t* according to the *t-1* expenditures, between the IG and the CG and controlled by the following confounders: age (< 50 years old, 50-60 years old, 60-70 years old, 70-80 years old, > 80 years old), gender (woman or man), location within the department (north, south), type of Mandatory Social Security Scheme (salaried/employees or farmers people), the presence of treatment indicating lipid troubles and/or cardiovascular complications of diabetes (present or not), type of medicinal treatment

[3] Glycosylated haemoglobin, glycated haemoglobin or more simply blood sugar provides the measurement of red blood cells fixing glucose in the haemoglobin of the organism. This concentration depends on cumulated variations of glycemia (rate of glucose in the blood) during the last 3-4 months. HbA1c expresses the glycemic control of a type 2 diabetes patient. This is why it is recommended to dose it every three months. In a non-diabetic individual, less than 6% of haemoglobin is glycated.

[4] The panel was called General Medicine Observatory (*Observatoire de la médecine générale* – http://omg.sfmg.org) of the French Society of general medicine (*Société Française de Médecine Générale* – http://www.sfmg.org/).

for diabetes (one oral antidiabetic drug, the association of two oral antidiabetic drugs, the association of oral antidiabetic drug and insulin), hospitalization (at least one hospitalization in t-1, at least one hospitalization in t, at least one hospitalization in t and in t-1, none).

3. Results

Descriptive statistics show that type 2 diabetes patients included in the experiment ASALEE are significantly better followed than other control patients, for all the process outcomes retained at the two consecutive periods , and that the improvement between the two periods is greater for them (Cf. Table 2).

Table 2 - Descriptive statistics at baseline (t-1) and over one year (t) for efficacy according to process outcomes measures (follow-up procedures) between intervention and control groups

Standard follow-up procedures recommended by national guidelines every year	Period (t-1) between July 2005-June 2006			Period (t) between July 2006-June 2007			Variation rate between (t-1) and (t)	
	ASALEE experiment (%)	Control Group (%)	Differences between groups (p-value)	ASALEE experiment (%)	Control Group (%)	Differences between groups (p-value)	ASALEE experiment (%)	Control Group (%)
>= 3 examination of HbA1c	46.78	35.27	0.000	61.93	44.5	0.000	32.38	26.17
>=1 examination of creatinemia	79.95	75.34	0.009	91.53	81.53	0.000	14.48	8.22
>=1 examination microalbuminuria	49.4	17.78	0.000	64.56	21.71	0.000	30.69	22.10
>=1 examination lipid check-up	67.18	58.06	0.000	83.53	66.21	0.000	24.34	14.03
>=1 Electrocardiogram or visit with a cardiologist	24.94	21.51	0.040	46.54	27.21	0.000	86.61	26.50
>=1 funduscopy or or visit with an ophtalmologist	40.43	36.27	0.060	43.21	37.54	0.018	6.88	3.50

Logistics models confirm this fact (see Table 3) and we therefore observe, *ceteris paribus*, that a type 2 diabetes patient followed up in the ASALEE experiment has, depending on procedures, 2.1 to 6.8 times more chances than one followed-up by another “standard” GP of remaining or becoming well followed-up over one year (OR equals 2.1 for HbA1c to 6.8 for microalbuminuria tests).

The fact that a type 2 diabetes patient within the IG benefits from a visit for education and counselling provided by nurses – 44% of patients were concerned – does not increase dramatically these odd-ratios, even if they all increase except for carrying out creatinemia measurements (see Table 4).

Table 3 - Modelling of the efficacy according to process outcomes measures (follow-up procedures)

	HbA1c		Microalbuminuria		Funduscopy		Creatinemia		ECG		Lipid checkup	
	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value
Intervention or Control Groups												
Controlled Group	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
ASALEE experiment	2.12	<.0001	6.816	<.0001	1.254	0.0462	2.534	<.0001	2.401	<.0001	2.617	<.0001
Age												
< 50 years old	0.454	<.0001	0.693	0.0838	0.731	0.1661	0.48	0.0015	0.476	0.0013	0.704	0.0989
50-60 years old	0.686	0.0085	0.766	0.0887	1.003	0.9871	0.734	0.1046	0.84	0.2512	0.934	0.687
60-70 years old	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
70-80 years old	1.1	0.4501	0.937	0.6329	1.217	0.1836	1.479	0.0401	1.466	0.0032	0.879	0.3816
> 80 years old	1.286	0.1545	0.596	0.0081	0.995	0.9828	1.702	0.0607	1.069	0.7141	0.385	<.0001
Gender												
Woman	1.034	0.7368	1.038	0.7281	1.341	0.0103	1.072	0.6194	0.765	0.0093	1.033	0.7691
Man	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Localisation within the *Deux-Sèvres* department												
North	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
South	0.699	0.0012	0.765	0.0253	0.971	0.8147	1.015	0.9261	0.552	<.0001	0.87	0.2701
Type of Mandatory Social Security Scheme												
General (salaried people)	0.826	0.0804	1.162	0.2111	-	-	0.906	0.5368	1.152	0.2165	1.121	0.3461
Farmer (farmer people)	*Ref.*		*Ref.*		-	-	*Ref.*		*Ref.*		*Ref.*	
Presence of medicated diabetes complication												
Yes	0.967	0.8568	0.914	0.6519	1.466	0.0859	1.54	0.0523	2.037	0.0014	1.945	0.0005
No	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Type of medicine treatment												
one oral antidiabetic drug	0.465	<.0001	0.598	<.0001	0.965	0.7891	0.623	0.004	0.739	0.0112	0.914	0.4789
association of two oral antidiabetic drugs	0.778	0.0497	0.814	0.1346	1.227	0.168	0.794	0.2263	0.877	0.3165	1.104	0.5007
association of oral antidiabetic drug and insulin	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Adjustment statistics												
Deviance	436.76	<.0001	358.48	0.0228	182.19	0.3588	316.56	0.3414	330.53	0.1703	344.84	0.0675
Pearson	363.55	0.0146	307.75	0.4771	154.34	0.8789	315.36	0.359	289.12	0.7608	301.12	0.5839
Wald test	140.79	<.0001	336.38	<.0001	24.32	0.0068	85.99	<.0001	145.26	<.0001	111.26	<.0001
Pseudo R2	0.0610		0.1563		0.0141		0.0619		0.0682		0.0572	
Percent Concordant	66.3		75.2		56.5		66.9		66.8		65.4	
Somers' D	0.335		0.514		0.154		0.351		0.345		0.318	
ROC curve	0.667		0.757		0.577		0.675		0.672		0.659	
gamma	0.338		0.519		0.158		0.355		0.348		0.321	

Ref.: modality of reference

Table 4 - **Regression results for the logistic model of becoming or still be followed correctly over one year for six procedures between the ASALEE experiment and the controlled groups**

	HbA1c		Microalbuminuria		Funduscopy		Creatinemia		ECG		Lipid checkup	
	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value
Intervention or Control Groups												
Controlled Group	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
ASALEE experiment without nurses visits for patient education and counselling	*1.868*	*<.0001*	*6.716*	*<.0001*	*1.207*	*0.1799*	*2.761*	*<.0001*	*2.547*	*<.0001*	*2.154*	*<.0001*
ASALEE experiment withnurses visits for patient education and counselling	2.445	<.0001	6.926	<.0001	1.303	0.0597	2.324	<.0001	2.698	<.0001	2.7	<.0001
Age												
< 50 years old	0.449	<.0001	0.692	0.0829	0.728	0.1622	0.482	0.0016	0.703	0.0974	0.472	0.0011
50-60 years old	0.681	0.0074	0.765	0.0878	1.001	0.9945	0.735	0.1074	0.934	0.683	0.835	0.2349
60-70 years old												
70-80 years old	1.096	0.4677	0.936	0.6305	1.215	0.1885	1.481	0.0392	0.879	0.3794	1.461	0.0035
> 80 years old	1.295	0.1438	0.597	0.0083	0.997	0.9891	1.698	0.0619	0.385	<.0001	1.076	0.6878
Gender												
Woman	1.02	0.8446	1.036	0.7425	1.337	0.0113	1.079	0.5901	1.031	0.7864	0.754	0.0065
Man												
Localisation within the *Deux-Sèvres* department												
North												
South	0.705	0.0017	0.767	0.0264	0.973	0.8324	1.01	0.9487	0.872	0.2789	0.557	<.0001
Type of Mandatory Social Security Scheme												
General (salaried people)	0.821	0.0726	1.161	0.2136	-	-	0.908	0.5454	1.12	0.3506	1.146	0.2334
Farmer (farmer people)	*Ref.*		*Ref.*		-	-	*Ref.*		*Ref.*		*Ref.*	
Presence of medicated diabetes complication												
Yes	0.961	0.8291	0.913	0.649	1.464	0.0868	1.543	0.0512	1.943	0.0005	2.026	0.0015
No	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Type of medicine treatment												
one oral antidiabetic drug	0.467	<.0001	0.598	<.0001	0.967	0.8002	0.621	0.0039	0.914	0.4814	0.742	0.0123
association of two oral antidiabetic drugs	0.779	0.0507	0.814	0.1347	1.229	0.1651	0.793	0.2251	1.104	0.5004	0.877	0.3174
association of oral antidiabetic drug and insulin	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Adjustment statistics												
Deviance	538.03	<.0001	464.40	0.011	270.90	0.0491	389.95	0.5902	431.40	0.113	468.17	0.0079
Pearson	444.41	0.0502	390.11	0.5879	224.44	0.6617	422.81	0.1787	385.04	0.6573	397.08	0.4895
Wald test	143.16	<.0001	336.42	<.0001	24.55	0.0171	86.21	<.0001	111.27	<.0001	147.27	<.0001
Pseudo R2	0.0623		0.1563		0.0143		0.0623		0.0572		0.0693	
Percent Concordant	66.5		75.3		0.156		66.9		65.5		66.9	
Somers' D	0.338		0.514		0.495		0.351		0.32		0.347	
ROC curve	0.669		0.757		0.578		0.676		0.66		0.674	
gamma	0.34		0.518		0.159		0.356		0.324		0.35	

Ref.: modality of reference

With respect to the evolution of HbA1c value over one year, descriptive statistics and t-test (see Table 5) show that the type 2 diabetes patients enrolled in the ASALEE experiment, and who experienced a visit for education and counselling, had a statistically significant greater percentage point reduction in their HbA1c level (-0.34) than that of ASALEE patient without any nurses visits (-0.13) and of control group patients (-0.1).

Table 5 - **Before and after descriptive statistics for efficacy according to the final outcome measure (glycemic control) for the ASALEE experiment and the controlled groups**

		Descriptive statistics				Non parametric Test			
		Control Group	ASALEE experiment			Control Group	ASALEE experiment		
			Nurses visits for education and counselling				Nurses visits for education and counselling		
			No	Yes	Total		No	Yes	Total
						Differences in means between ASALEE experiment and Control Group: T-Test (statistics and p value)			
HbA1c before	n	202	376	212	588				
	mean	7.36	7.08	7.29	7.16		2.58	0.55	1.91
	std	1.33	1.06	1.24	1.13		*(p<1%)*	*(p>10%)*	*(p<10%)*
HbA1c after	n	202	376	212	588				
	mean	7.26	6.95	6.95	6.95		3.11	2.68	3.25
	std	1.21	1	1.14	1.05		*(p<1%)*	*(p<1%)*	*(p<1%)*
Evolution over one year	n	202	376	212	588				
	mean	-0.1	-0.13	-0.34	-0.2		0.33	2.40	1.15
	std	1.12	0.87	0.9	0.89		*(p>10%)*	*(p<5%)*	*(ns)*
						Before-and-After differences in proportions: Mac Nemar Test (p-value)			
HbA1c before									
<= 6.5%	n	58	127	65	192				
	%	28.71	33.78	30.66	32.65				
[6.6%;8%]	n	96	198	91	289				
	%	47.52	52.66	42.92	49.15				
> 8%	n	48	51	56	107				
	%	23.76	13.56	26.42	18.2				
HbA1c after									
<= 6.5%	n	67	154	89	243	0.1797	0.0021	<.0001	<.0001
	%	33.17	40.96	41.98	41.33				
[6.6%;8%]	n	89	173	99	272				
	%	44.06	46.01	46.7	46.26				
> 8%	n	46	49	24	73	0.7518	0.7855	<.0001	0.0004
	%	22.77	13.03	11.32	12.41				
Total	n	202	376	212	588				
	%	100	100	100	100				

Notes: p value in bold are significant (p<10%)

The specific effect of the level 2 nurse intervention on the improvement of the glycemic control, within the ASALEE experiment and compared to the control group, is confirmed by the results of logistic models (see Table 6).

We observe that the probability of maintaining one's HbA1c or reducing it to 8% or less over one year is 1.8 times greater for the type 2 diabetes patients in the ASALEE group than for those in the control group (OR=1.8 for p<5%), *ceteris paribus*. Nevertheless, when seeking a more stringent judgement criterion, *i.e.* when the HbA1c threshold chosen is 6.5% or 7%, no significant differences were observed between the two groups.

That being said, when ASALEE patients are distinguished according to whether they were given at least one visit for education and counselling performed by nurses, there is a very significant improvement of glycemic control in the intervention group compared to the control group. We observed that the highest probability of having a HbA1c rate maintained at the same level or reduced to 8% or less over one year only significantly concerned patients who had had at least one therapeutic education (OR=2.7, p<1%). Moreover, the result is robust when applying a more stringent judgement criterion, i.e. an HbA1c threshold reduced to 6.5% or 7% (OR equal to 1.6 and 1.8 respectively with p≤5%).

Table 6 - Regression results for the logistic model of maintaining or reducing HbA1c, before-and-after the intervention, regarding the three different thresholds of glycemic control, between the ASALEE experiment and the controlled groups

	<= 6,5%		<= 7%		<= 8%		<= 6,5%		<= 7%		<= 8%	
	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value	Odds ratio	p value
Intervention or Control Groups												
Controlled Group	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
ASALEE experiment	1.335	0.1744	1.199	0.3747	1.753	0.0206						
or ASALEE experiment without patient education and counselling performed by PHN							1.152	0.5339	1.022	0.9223	1.368	0.2388
ASALEE experiement with patient education and counselling performed by PHN							1.803	0.0258	1.628	0.0572	2.673	0.0022
Age												
< 65 years old	1.502	0.0349	1.178	0.389	0.924	0.742	1.538	0.0264	1.19	0.3599	0.899	0.6593
>= 65 years old	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Gender												
Woman	0.734	0.0907	0.988	0.9477	1.155	0.5319	0.713	0.0661	0.961	0.8243	1.12	0.6237
Man	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
Hba1c at baseline	0.19	<.0001	0.233	<.0001	0.375	<.0001	0.186	<.0001	0.227	<.0001	0.364	<.0001
Number of Hba1c realized	0.94	0.7525	1.13	0.5272	1.021	0.9342	0.903	0.6044	1.084	0.6786	0.969	0.9027
Number of months of follow up	0.946	0.2002	0.951	0.2362	0.901	0.0576	0.947	0.2091	0.953	0.2526	0.906	0.0716
Seasonality												
06/2004 - 12/2004	*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*		*Ref.*	
02/2005 - 07/2005	0.9	0.6508	1.189	0.4355	1.221	0.4719	1.018	0.9425	1.364	0.1832	1.418	0.2214
01/2006 - 06/2006	1.707	0.0155	1.876	0.0039	1.592	0.0951	1.861	0.006	2.055	0.0013	1.787	0.0427
Adjustment statistics												
Deviance	715.87	0.8028	743.15	0.5534	506.06	1	720.42	0.826	752.86	0.5357	509.64	1
Pearson	3352.97	<.0001	1107.44	<.0001	646.47	0.9971	3941.26	<.0001	1185.25	<.0001	677.62	0.9821
Wald test	170.81	<.0001	168.79	<.0001	109.94	<.0001	171.50	<.0001	169.23	<.0001	110.53	<.0001
Pseudo R2	0.2974		0.2764		0.2236		0.3009		0.2803		0.2306	
Percent Concordant	85.9		84.8		84.2		86,00		85,00		84.9	
Somers' D	0.72		0.697		0.686		0.722		0.701		0.702	
ROC curve	0.86		0.849		0.843		0.861		0.85		0.851	
gamma	0.721		0.698		0.688		0.723		0.702		0.704	

Ref.: modality of reference

We estimated for type 2 diabetes patients total direct cost (*e.g.* for all procedures) and total direct cost specific to type 2 diabetes (*e.g.* only for procedures regarding type 2 diabetes, its risk factors and complications) between two consecutive periods: between July 2005-June 2006 (t-1) and between July 2006-June 2007 (t). It appears that the costs of ASALEE patients are equivalent to those of the patients of the controlled group for the two periods. For the total cost, they are respectively around 3.000 € in t and of 2.400 € in t-1.From the model we could conclude, *ceteris paribus*, in the absence of statistically significant difference in the progression of expenditure between patients followed up in ASALEE and patients of the control group. Finally, we have estimate the "theoretical" thresholds of additional cost from which we could consider that the differences in the progression of the expenditure would be significant between the ASALEE patients and those of the control group. From a step-by-step modelling and on the basis of our samples, we estimate these thresholds at 640 € for the total cost and at 470 € for the cost attributable to the diabetes, to its risk factors or to the complications.

Table 7 - Regression results for the linear regression of total costs and specific to diabetes costs in t according to the t-1 expenditures and between the ASALEE experiment and the controlled groups

	Total costs in t		Total cost in t specific to diabetes	
	Coefficient	p value	Coefficient	p value
Intercept	2092.24	<.0001	2083.64	<.0001
Intervention or Control Groups				
Controlled Group	Ref	-	Ref	-
ASALEE experiment	-81.28	0.465	-60.75	0.388
expenditures in t-1	0.48	<.0001	0.46	<.0001
Age				
< 50 years old	-504.82	0.026	-178.94	0.212
50-60 years old	-111.73	0.496	22.5	0.829
60-70 years old	Réf.	-	Réf.	-
70-80 years old	-65.78	0.65	102.99	0.261
> 80 years old	563.87	0.005	324.13	0.011
Gender				
Woman	-120.57	0.28	-106.51	0.132
Man	Ref		Ref	
Localisation within the *Deux-Sèvres* department				
Nord	Ref		Ref	
Sud	184.18	0.142	163.81	0.039
Type of Mandatory Social Security Funds				
General (salaried people)	57.62	0.644	-25.58	0.747
Farmer (farmer people)	Ref		Ref	
Presence of medicated diabetes complication				
Yes	684.6	0.002	287.73	0.04
No	Ref		Ref	
The type of medicinal treatment for diabetes				
one oral antidiabetic drug	-1942.58	<.0001	-1920.74	<.0001
association of two oral antidiabetic drugs	-1827.36	<.0001	-1749.99	<.0001
association of oral antidiabetic drug and insulin	Ref		Ref	
Hospitalization				
at least one hospitalization in t-1	-1350.82	<.0001	-517.71	<.0001
at least one hospitalization in t	3757.56	<.0001	1385.47	<.0001
at least one hospitalization in t and in t-1	2524.8	<.0001	927.66	<.0001
none	Ref		Ref	
Adjustment statistics				
R^2	0.5153	-	0.4772	-
R^2 adjusted	0.5111	-	0.4727	-

Ref.: modality of reference

4. Discussion and conclusions

The main purpose of this study was to provide some empirical evidence about the efficacy and the efficiency of the French team work experiment ASALEE – mixing GPs and nurses skills – regarding the management of type 2 diabetes patients. More specifically, following a general design of a controlled before–and–after study, some logistic and linear models were estimated to assess: first, the efficacy according to process (adequacy of follow-up procedures) and final outcomes (glycemic control); second, the differential impact between two levels of nurses intervention in complement to the GP (systematic electronic patient registry and electronic clinical reminder with or without patient education and counselling); third, the impact on direct cost including additional cost generated by the experiment.

With regard to the significant greater improvement, both of the follow-up adequacy and of the glycemic control, for the type 2 diabetes patients enrolled in the ASALEE experiment compared with those followed by “standard” GP practices, such an experiment could be considered as globally effective. In other words, the added value of teamwork between GPs and nurses is clearly demonstrated both for glycemic control (with the nurse visits for education and counselling) and process outcomes (with the nurse electronic patient registry and electronic GP reminder).

The improvement of the adequacy with guidelines regarding process outcome indicators calls for some comments. Firstly, it should be noticed that the positive impact on process outcome improvement for the follow-up of diabetes patients is in line with the results of the only evaluation of a French health care network yet published in France [35]. It is also in line with a great number of literature reviews [2,8-12,22,37] with very similar design and method and for various quality improvement programs involving nurses (i.e. disease management, case management, team work or skill-mix experiment…). Secondly, in 2007, the level of adequacy with guidelines for process outcome in the ASALEE experiment were equivalent or not so far from those achieve in UK [37] and much greater than those observed by the French national survey on diabetes patients [28] for all the indicators except for carrying out eye examinations.

The positive results regarding our final outcome, the improvement of the HbA1c rate and then of the proportion of patients be under glycemic control, were rather innovative because the studies that assess this type of outcomes were in a much more restricted number. It has been shown that the rate of Hba1c significantly decreased over one year in the ASALEE experiment with a points percentage reduction of 0.2 for all patients included and of 0.34 for patients who had experienced the nurses visits for education and counselling. Then we observed an increase in the proportion of diabetes patients under glycemic control over a year significantly greater than in the control group.

This should be compared first to the secular trend affecting the HbA1c, and second to what it was observed in other studies. First, the experience of the UKPDS study demonstrated that the natural trend of HbA1c was to be worsened at a rate around 0.2% per year over a 10-year cohort observation period [38]. Second, the relative decrease in HbA1c here are consistent with the results of other studies with a very similar design and method and for various quality improvement programs: most of the studies observed a rather significant reduction of the Hba1c level, comprised between a 0.4 and a 1.0 point percent reduction, and then an increase in the proportion of diabetes patients under glycemic control [36-44].

None of these studies concerned French experiments, and it is only recently that a disease management program lead by the National Health Insurance Fund for salaried people has been experimentally implemented for a targeted population of 140,000 diabetic patients. It is called SOPHIA and the results of its evaluation for final outcomes should not be available before mid-2010[5].

A final set of results concerns the progression of costs over one year. These are not significantly higher in the ASALEE experiment than in the control group even if we take into account the additional cost generated by the experiment (*i.e.* nurses’ wages,…): €60/yr per patient. These additional costs was estimated by ASALEE on the basis of its accounts and its own records of nurse working time dedicated to the follow-up of diabetes patients. They should be compared to the one estimated by the National Health Insurance Fund for employee for the SOPHIA experimental disease management on a routine basis: €120/yr per patient. Moreover, as has been shown by the sensitive analysis, this is still the truth even if we let up the hypotheses for the additional costs in the ASALEE experiment and if we reached them to a very high threshold (€640/yr per patient for the total cost and €470/yr per patient for the cost attributable to the follow-up or treatment of diabetes, its risk factors or its complications).

It should be mentioned that expenditure over one year is less here than that estimated by the French National Health insurance Fund for types 1 and 2 diabetes patients in long-term disease [25,30]. This difference can mainly be explained by the fact that our sample is made up in the same way and that it is limited to patients covered by health insurance in the *Deux-Sèvres* department. It does not represent diabetic patients with complications leading to high expenses (e.g. diabetes patients under dialysis). Furthermore, it was not possible to take public hospital expenses fully into account. The

[5] See for futher information: http://www.ameli.fr/professionnels-de-sante/medecins/vous-former-et-vous-informer/sophia-un-service-pour-les-malades-chroniques.php ;http://www.apmnews.com/story.php?numero=188739

exhaustiveness of the collection is better in t than in t-1, explaining part of the increase in expenditure between the two periods.

Nonetheless, our results are consistent with the results of existing studies in other countries in terms of cost progression, relatively moderate, on a short-term basis when a quality improvement program for chronic disease was implemented [13,14,40,45]. The progression is due to the fact that the costs saving are expected in long term schedule. The progression is moderate because marginal cost of the procedures that should be run in order to ensure a better follow-up are very low regarding the total expenditure of diabetes patient.

Finally, the model of GP nurse cooperation developed within the ASALEE natural experiment can be considered as efficient. This evaluation contribute to the large national policy experiment of skill mixing which gives place to a series of works, namely a recent national recommendation by the French National Authority in Health (*Haute Autorité de Santé*, HAS) and the National Observatory of Health Professions (*Observatoire National de la Démographie des Professionnels de Santé*, ONDPS 2008) in April 2008 (HAS 2008). The recommendation requested a number of reforms on the education and training of health professionals, provided a regulatory framework for developing cooperation and argued in favour of their necessity. At least in France the question remains to modify model of financing primary care organisations who are involved in such quality improvement organisational strategy for chronic disease case management directly implemented by professional compared with disease management program models led directly by the National Health Insurance Funds, like the Sophia experiment.

Some limitations should be taken into account in our study. Firstly, there is no random selection of GPs, nurses and patients and then some selection bias could occur. Secondly, we have a case study design extended to a controlled before-and-after design only for the evaluation of the final outcome but not for the evaluation of process outcomes and cost. Nevertheless, for the latter, we are able to implement a clear controlled before-and-after design, but only for a subsample of type 2 diabetes patient within the ASALEE experiment, those who were included during the final wave of the experiment (respectively 382 and 356 patients). We have run these models and the results still are robust for these subsamples. Thirdly, our patient attrition rate – mainly due to a change of location or because of a death – was about 13%. Fourthly, the evaluation was restricted to a proportion of all the eligible ASALEE patients: 40% for the glycemic control, 47% for the process outcomes and 49% for the costs. Fifthly, we could not include in our analysis some important unavailable variables: clinical and socioeconomic status variables with a broader scope than for those available here (*e.g.* occupation, income, education); other final outcome (e.g. body mass index, microvascular and macrovascular complications, quality of life). Finally, the conclusions in terms of efficiency are not based on a joint analysis of effectiveness and cost at the individual level and the observation length is limited.

Acknowledgements

This project was co-funded by the French National Authority for Health (*HAS – Haute Autorité de Santé*). We would like to thank: the members of ASALEE association and the health care professionals involved in this experimentation and especially to I. Rambault-Amoros and J. Gautier; the physicians of the OMG (General Medicine Observatory) from the SFMG association and especially to G. Hebbrecht; from IRDES: N. Grandfils, N. Le Guen, C. Ordonneau and G. Haour - for their participation to data management - C. Allonier, N. Grandfils and M. Naiditch - for their comments.

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Effect of a French Experiment of Team Work between General Practitioners and Nurses on Efficacy and Cost of Type 2 Diabetes Patients care

Julien Mousquès, Yann Bourgueil, Philippe Le Fur (Irdes, Prospere), Engin Yilmaz (Drees)

This study aims to assess the efficacy and the cost of a French team work experiment between nurses and GPs for the managing of type 2 diabetes patients.
Our study was based on a case control study design in which we compare the evolution of process (standard follow-up procedures) and final outcomes (glycemic control), and the evolution of cost. The study is realized between two consecutive periods between type 2 diabetes patients followed within the team work experiment (intervention group) or by "standard" GPs (controlled group).
After a 11 months of follow-up, we showed that patients in the intervention group, compared with those in the controlled group, have more chances to remain or to become: correctly followed-up (with OR comprise between 2.1 to 6.8, p<=5%) and under glycemic control (with OR comprise between 1.8 to 2.7, p<=5%). The latter result is obtained only when a visit for education and counselling has been delivered by a nurse in supplement to systematic electronic patient registry and electronic clinical GPs reminder. All these results are obtained without difference in costs between the intervention and the controlled group.
Finally, this experimentation of team working can be considered both effective and efficient. Our findings may have implications in the design of future larger primary care team work experiments to be launched by French health authorities.

L'impact d'une expérimentation française de travail en équipe, entre généralistes et infirmières, sur l'efficacité et les coûts du suivi des patients diabétiques de type 2

Julien Mousquès, Yann Bourgueil, Philippe Le Fur (Irdes, Prospere), Engin Yilmaz (Drees)

Cette étude a pour objectif d'évaluer l'efficacité et les coûts d'une expérimentation de travail en équipe entre des infirmières et des généralistes (l'expérimentation ASALEE), dans le cas de la prise en charge des patients souffrant de diabète de type 2.
Elle s'appuie sur un *design* cas/témoin dans lequel nous comparons l'évolution des résultats de soins en termes de processus (procédures standards de suivi) et de résultat final (le contrôle glycémique), ainsi qu'en termes de coûts. Cette comparaison est réalisée entre deux périodes consécutives et entre des patients diabétiques de type 2 suivis dans l'expérimentation (le groupe d'intervention) ou dans le groupe témoin (le groupe contrôle).
Nous montrons qu'après onze mois de suivi, les patients ASALEE, comparés à ceux du groupe témoin, ont une plus grande probabilité de rester ou devenir bien suivis en termes d'indicateurs de processus (OR compris entre 2.1 à 6.8, p < 5 %), ainsi qu'en termes de contrôle glycémique (OR compris entre 1.8 à 2.7, p < 5 %). Ces derniers résultats sont obtenus uniquement lorsque les patients ont bénéficié d'au moins une consultation infirmière d'éducation et de conseils hygiéno-diététiques en complément du rôle classique des infirmières dans le cadre de l'expérimentation ASALEE, c'est-à-dire la mise à jour des dossiers médicaux informatisés avec l'inscription éventuelle de rappels informatiques à destination des généralistes.

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ISBN : 978-2-87812-356-2 ISSN: 2102-6386