Opening doors to basic-clinical collaboration and translational research will improve researchers' performance

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Abstract

The present study investigate to what extent basic-clinical collaboration and involvement in translational research improve performance of researchers, in the particular setting of hospitals affiliated with the Spanish National Health System (NHS). We used a combination of quantitative science indicators and perception-based data obtained through a survey of researchers working at NHS hospitals. Although collaborating with clinical researchers and health care practitioners may increase productivity of basic researchers working in clinical settings, the extent to which they are able to contribute to translational research is the factor that allows them to make a qualitative leap in their scientific production in highly ranked international scientific journals. Our results challenge the arguments by some authors that translational projects have more difficulties than basic proposals to be granted by funding agencies and to be published in high–impact journals. Although they are not conclusive, our results point towards the existence of a positive relationship between leadership and involvement in translational research. Basic-clinical collaboration and translational research should be an incentive for researchers as they are likely to favour their performance. Hospitals will benefit from encouraging researchers and health care practitioners to collaborate in the framework of translational projects, as a way to improve not only individual, but institutional research performance. Spanish hospitals should contribute to overcome obstacles to translational research, through the full integration of basic researchers within the hospital setting and the definition of a research career path within the NHS.

Keywords

biomedical research; public health care sector; basic-clinical collaboration; translational research; research performance; perception survey

Introduction

Health care institutions are coming to the fore as stakeholders in research as a result of their efforts to enhance research as the third element in their three-fold mission, together with health care provision and education (Weber-Main et al. 2013; Rey-Rocha and López-Navarro 2014). Basic-clinical collaboration, i.e. collaboration between basic researchers, clinical researchers and health care practitioners, is flourishing in parallel with the emergence and development of new contexts for research at health care institutions (Arias 2004; Cripe et al. 2005; Hobin et al. 2012). To Rodés (interviewed by Bosch, 2000) "coordination of both clinical and basic research with medical practice will improve the implementation of scientific advances in the prevention, diagnosis, and treatment of diseases, and guarantee better health care services".

Translational research is a paradigm of basic-clinical collaboration. It involves relationship between clinical and basic researchers, the transfer of scientific knowledge from basic research to clinical practice (from bench to bedside), and the generation of biomedical research questions and hypotheses based on clinical practice (from bedside back to bench) (Rubio et al. 2010; Lander and Atkinson-Grosjean 2011; Drolet and Lorenzi 2011). Therefore, it requires team approaches and the partnership of individuals from different fields and professional profiles, expertise and skills (Hörig et al. 2005; Hobin et al. 2012).

Apart from its social impact, engaging in basic-clinical collaboration and translational research can have an academic impact. Indeed, it may professionally benefit basic scientists, and consequently their institutions, by garnering additional funding and more opportunities to lead new projects, as well as increasing scientific output (He et al. 2009; Bornstein and Licinio 2011; Pozen and Kline 2011; Hobin et al. 2012). But basic-clinical collaboration and translational research should not be assumed to "lead inexorably to higher or better research output" (He at al. 2009) or to better research performance, as they entail various difficulties and costs that may outweigh the benefits (Joiner 2005; Hobin et al 2012; Littman et al. 2007).

The Miguel Servet (MS) Research Contract Programme, implemented within the Spanish National Health System (NHS), employs scientists who are experienced in basic research, in NHS hospitals and their associated research centres (Rey-Rocha and Martín-Sempere 2012). This incorporation of basic scientists into the essentially clinical hospital environment has contributed to generate favourable contexts for basic-clinical collaboration and translational research.

Obtaining funding for research projects and the publication of scientific articles are understood to be among researchers' most important –if not the most important– activities and targets. Accordingly, publication of papers in world-leading journals, and leadership of research groups and funded research projects, are the most commonly used metrics of research performance (Feldman 2008; Pozen and Kline 2011; Lee et al. 2012) and are also the primary measures used by the MS Programme funding and managing agency –the Carlos III Institute of Health– to assess MS researchers' performance and success (Antonio-García et al. 2014).

In a previous paper (Antonio-García et al. 2014) involvement of MS researchers in clinical research was found to be associated with increased scientific productivity –both overall and in high-impact journals– and improved competitiveness in obtaining research funding as principal investigator. Our results showed that, in the setting of NHS health care and research centres, scientists with a background mainly in basic research obtain opportunities to become more productive as a result of their participation in clinical research and collaboration with clinical colleagues. We argued that these data implicitly support the relevance of translational research.

Under these premises, the present study investigate, in the particular setting of public health care, to what extent basic-clinical collaboration and involvement in translational research improve performance of researchers, as measured in terms of success in the competition for funding and competition to publish in international refereed journals. To the best of our knowledge, empirical analyses of the academic benefits of basic-clinical collaboration and translational research for researchers working at the health care setting, is missing in prior literature. Although translational scientists may have sometimes found it challenging to publish their research results and to be evaluated favourably by tenure and promotion committees (Bornstein and Licinio 2011; Hobin et al. 2012), our underlying assumption is that basic-clinical collaboration and involvement in translational research are likely to favour researchers' performance. Thus they can be an incentive for researchers working in the health care setting.

Methodology

A detailed description of the methodology used in this research was published elsewhere (Antonio-García et al. 2014). It is based on a combination of quantitative science indicators and perception-based data obtained through a survey of researchers working at NHS hospitals. To facilitate comprehension, below we summarize key methodological aspects of the study and describe details of the methodology used for the particular analysis reported here.

Population, data collection and sample

The universe to be studied consisted of all researchers funded by the first eight calls for applications to the MS Programme (1998–2005). This population comprised 367 individuals (52.6 % men) who worked at 66 different hospitals and 22 research centres. To ensure a homogeneous sample, in this study we considered only researchers who a) completed their full six-year contract period –we disregarded those who had not reached the end of their contract–; and b) were employed at a hospital –we disregarded those working at NHS research centres–.

We used a web-based structured questionnaire to obtain data about different aspect of researchers' activity and their beliefs, perceptions, judgements and feelings about this activity and its organizational context. The overall response rate was 72.2% (265 valid answers). Research career data were obtained from the researchers' curricula vitae attached to their MS contract application. Data on participation in and leadership of funded research projects and articles published in refereed scientific journals were obtained from the activity reports submitted by researchers at the end of their contracts.

The final sample is constituted by 139 individuals (84.7%) who fulfil both conditions, who responded our survey and from whom full data on their participation in research projects and their scientific production were available from their activity reports. They worked at 46 different hospitals and 51.1% are women. The largest proportion of researchers had obtained their doctorate in biology (48.2%), and fewer had obtained their doctorate in medicine and surgery (19.4%), pharmacy (11.5%), chemistry (7.2%) and other specialties (13.7%) including biochemistry, microbiology, molecular biology, pharmacology, physics, physiology, sciences, veterinary and virology.

Variables

In this paper we analyse researchers' performance in terms of their success in the competition for research funds and for publishing scientific articles in international refereed journals (see Table 1, 'dependent variables'). Scientific productivity is measured as the number of authorships per individual per time unit (the 6-year period of scientific activity analysed) in journals covered by the Thomson–Reuters Web of Science (WoS) database. Additionally, we consider articles published in first-quartile (Q1) journals, i.e. journals listed in the top 25 % of their Thomson–Reuters Journal Citation Reports (JCR) subject category when ranked by their impact factor (IF). Responsibility for projects as the principal investigator and principal (first or last) authorship of articles are also used as indicators of leadership. Data were obtained from the activity reports submitted by researchers at the end of their contracts.

Research collaboration is usually measured through co-authorships of research papers. This approach presents numerous advantages, but it shows certain methodological gaps (Subramanyam 1983; Katz and Martin 1997; He et al. 2009). For the purposes of the present study, the most relevant gap is that authorships do not give any information of the "quality" of collaboration. Particularly, they do not inform on the extent to which co-authored papers are the result of basic-clinical collaboration. Instead, here we use a perception-based approach, where contribution to basic-clinical collaboration and translational research is self-reported by scientists through a survey. This method enables analyses of research collaboration to be undertaken from a wider perspective. Collaboration can them be considered as two or more researchers or groups working together, sharing resources and efforts, either intellectual or physical (Katz and Martin 1997). For the purposes of this particular study, two different survey questions are used (see Table 1, 'independent variables'). Question 1 is about the type of research (basic, clinical and/or other) MS researchers and their colleagues carried out. Question 2 inquires about the three elements of translational research.

Table 1 Description of the variables and descriptive statistics

Dependent variables	**Descriptive statistics**
Indicators of research productivity and competitiveness	**Average ± standard deviation (range) median**
art-N	
Number of articles per researcher in refereed journals with impact factor included in the Web of Science (WoS) during the 6-year contract period	14.3 ± 9.5 (0-53) 12
art-Q1	
Number of articles per researcher in journals ranked in the first quartile of their subject category in Journal Citation Reports (JCR)	8.8 ± 6.0 (0-32) 7
art-FL	
Number of WoS articles per researcher as the first or last author	5.8 ± 5.2 (0-38) 4
art-Q1-FL	
Number of WoS articles per researcher in first-quartile journals as a first or last author	5.1 ± 4.1 (0-19) 4
proj-N	
Number of participations in funded research projects	8.9 ± 4.5 (1-29) 9
proj-PR	
Number of funded research projects as principal researcher	3.6 ± 2.3 (0-12) 3
Independent variables	**% researchers surveyed**
Basic / Clinical research	
Responses to Question 1**:** Please, identify the type of research you and your colleagues undertook during your MS contract. *One or more options: Basic; Clinical; Other*	Basic (exclusively) / Clinical (exclusively)/ Both / Not applying
Q1.a) The research I did during my contract was …	49.6 / 7.9 / 42.4
Q1.b) The research done by the other group members was ...	30.2 / 28.8 / 41.0
Q1.c) The research done by other colleagues at my centre with whom I worked was …	15.8 / 42.4 / 41.7
Q1.d) The research done by other colleagues at other centres with whom I worked was …	45.3 / 7.2 / 46.0 / 1.4
Basic-clinical collaboration	
According to responses to Question 1, respondents were assigned to one of the following categories, which identify to what extent they worked in a context where both basic and clinical research was done:	
Collaboration between basic and clinical researchers…	
…within the host group	66.2
…with colleagues of other groups at the same hospital	83.5
…with colleagues of other groups from other hospitals	67.6
Total, i.e. in any of the above circumstances	92.1
Contribution to translational research	
Responses to Question 2: Do you feel your incorporation as MS researcher has contributed to the interrelationship between basic and clinical researchers at the host centre?	5=Very substantial / 4=Substantial / 3=Moderate / 2=Small / 1=No contribution
Q2.a) I consider that my contribution to the interrelationship between basic and clinical researchers has been…	20.1 / 46.0 / 27.3 / 5.0 / 1.4
Q2.b) I consider that my contribution to knowledge transfer from basic biomedical research to clinical practice has been…	13.7 / 36.7 / 40.3 / 8.6 / 0.7
Q2.c) I consider that my contribution to the generation of questions and hypotheses for biomedical research based on clinical practice has been…	14.4 / 50.4 / 27.3 / 6.5 / 1.4

Data analysis

Descriptive statistical analyses were conducted to identify the basic indicators and determine the distribution of dependent and independent variables. Basic descriptive statistics are provided in Table 1.

In order to identify homogeneous groups of respondents based on their responses to question 2, and categories resulting from responses to question 1, we performed separate non-hierarchical, K-means cluster analysis with non-standardized variables. Cluster analysis' hit rate (i.e. percent of total cases correctly classified) was calculated through discriminant analysis. The 'cluster membership' variables were saved as new qualitative variables. Means for dependent variables across cluster membership categories were compared with non-parametric tests –the Kruskal-Wallis H test and the Mann-Whitney U test– as the data were not normally distributed. Statistical analyses were done with the Statistical Package for Social Sciences (SPSS) 21.0 for Windows. Differences were considered significant when $p < 0.05$.

Results

Most respondents undertook basic research exclusively (49.6%) or combined it with clinical research (42.4%), regardless of whether their group was involved in mainly basic, clinical or basic+clinical research. At their own hospitals they collaborated mainly with clinical or basic+clinical colleagues (42.4% and 41.7%, respectively), whereas extramural collaboration was mainly with basic or basic+clinical researchers (45.3% and 46.0%, respectively) (Table 1, variable 'basic/clinical research').

Almost all scientists surveyed (92.1%) worked in a context where both basic and clinical research was done. Around two thirds found this context of basic-clinical collaboration within their host group (66.2%) or collaborating with colleagues of other groups from other centres (67.6%), and more than 80% did it through collaboration with colleagues of other groups at the same hospital (Table 1, variable 'basic-clinical collaboration').

Two thirds of respondents considered to have substantially or very substantially contributed to the relationships between basic and clinical researchers at their own hospital. A similar percentage felt they contributed to the same extent to the generation of questions and hypotheses for biomedical research based on clinical practice, and half of respondents valued in the same manner their contribution to knowledge transfer from basic biomedical research to clinical practice (Table 1, variable 'contribution to translational research').

Analysis of the 'basic-clinical collaboration' variable resulted in five clusters (hit rate over 70 percent) grouping individuals according the contexts where they experienced collaboration between basic and clinical researchers (Table 2).

The three response items to question 2 are highly correlated –Pearson correlations significant at the 0.001 level (2-tailed): Q2a-Q2b=0.66; Q2a-Q2c=0.63; Q2b-Q2c=0.56– suggesting that knowledge transfer in both senses –from bench to bedside and vice versa– go together. Therefore cluster analysis resulted in three clusters (hit rate over 99%) grouping individuals characterized by a very homogeneous contribution (lower than average, medium or average, and higher than average) to all of the components of translational research (Table 3).

Table 2 Basic-clinical collaboration. Final cluster centres

Collaboration between basic and clinical researchers…	Cluster				
	#00	**010**	**0#1**	**110**	**111**
…within the host group	.3	.0	.0	1.0	1.0
…with colleagues of other groups at the same hospital	.0	1.0	.7	1.0	1.0
…with colleagues of other groups from other hospitals	.0	.0	1.0	.0	1.0
Number of cases in each cluster (2 missing)	14	12	24	17	70

Clusters are identified by a three-characters code where: 1 = Yes, 0 = No; # = Some. First digit indicates whether or not basic-clinical collaboration existed within the host group; second digit refers to basic-clinical collaboration with colleagues of other groups at the same hospital; third digit refers to collaboration with colleagues of other groups from other hospitals.

Clusters:

#00: *Some intra-group collaboration*: No collaboration with other groups; some cases of collaboration within the host group.

010: *Inter-group intra-centre collaboration*: Collaboration only with other groups at the same hospital.

0#1: *Inter-group inter-centre collaboration:* Collaboration with other groups from other hospitals and sometimes at the same hospital.

110: *Intra-centre collaboration*: Collaboration only within the same hospital, either within the host group or with other groups

111: *Wide-ranging collaboration*: Collaboration within the host group and with other groups, either at the same hospital or from a different centre.

Table 3 Contribution to translational research. Final cluster centres

	Cluster		
	Low	**Medium**	**High**
Contribution to the interrelationship between basic and clinical researchers	2.2	3.6	4.9
Contribution to knowledge transfer from basic biomedical research to clinical practice	2.2	3.4	4.5
Contribution to the generation of questions and hypotheses for biomedical research based on clinical practice	2.6	3.5	4.6
Number of cases in each cluster	13	94	32

Table 4 Collaboration between basic and clinical researchers. Summary of significant differences

Dependent variables	Collaboration basic/clinical (Cluster membership)				
	#00	**010**	**0#1**	**110**	**111**
	Average ± standard deviation (range) median				
art-N	11.1 ^{a,b} ± 6.9 (2-25) 10.5	**8.8 ^{b} ± 7.8** **(0-28) 6.5**	12.6 ^{a,b} ± 6.9 (2-29) 12	15.1 ^{a,b} ± 10.9 (4-39) 10	**16.6 ^{a} ± 10.1** **(2-53) 14.5**
art-Q1	7.1 ± 4.7 (2-19) 5	5.7 ± 4.0 (0-14) 5	8.8 ± 5.7 (2-25) 7.5	8.2 ± 6.1 (1-22) 6	9.9 ± 6.5 (0-32) 9
art-FL	4.4 ± 3.7 (0-11) 4	4.2 ± 4.1 (0-14) 3	5.3 ± 3.9 (0-13) 4	7.0 ± 6.4 (0-24) 4	6.4 ± 5.7 (0-38) 5
art-Q1-FL	3.9 ± 3.2 (0-11) 4	3.8 ± 4.1 (0-14) 3	4.8 ± 3.7 (0-13) 4	6.0 ± 5.5 (0-19) 4	5.5 ± 4.1 (0-18) 5
proj-N	8.3 ^{a,b} ± 4.5 (2-18) 7.5	**7.2 ^{b} ± 3.8** **(10-14) 6.5**	**7.4 ^{b} ± 3.9** **(2-16) 7**	**8.0 ^{b} ± 5.9** **(3-29) 7**	**10.1 ^{a} ± 4.2** **(3-22) 10**
proj-PR	3.9 ± 3.0 (1-12) 3	3.5 ± 2.3 (0-9) 3.5	3.3 ± 2.0 (0-7) 2.5	3.9 ± 2.5 (1-9) 3	3.6 ± 2.3 (0-10) 3

Mean values were compared with Kruskal-Wallis H test. Differences between pairs, with the Mann-Whitney U test

Values in the same row not sharing the same superscript (a or b) are significantly different at $p < 0.05$. Bold values indicate statistically significant differences

Table 5 Contribution to translational research. Summary of significant differences

Dependent variables	Contribution to translational research (Cluster membership)		
	Low	**Medium**	**High**
	Average ± standard deviation (range) median		
art-N	**10.1 ^{b} ± 6.8** **(4-25) 9**	14.1 ^{a,b} ± 10.0 (0-53) 12	**16.7 ^{a} ± 8.3** **(4-37) 18**
art-Q1	7.1 ± 5.3 (1-19) 6	8.8 ± 6.2 (0-32) 7	9.4 ± 5.8 (2-24) 8.5
art-FL	**2.6 ^{b} ± 2.4** **(0-9) 2**	**6.0 ^{a} ± 5.7** **(0-38) 4**	**6.6 ^{a} ± 4.2** **(1-18) 6.5**
art-Q1-FL	**2.5 ^{b} ± 2.4** **(0-9) 2**	**5.2 ^{a} ± 4.2** **(0-19) 4**	**5.8 ^{a} ± 4.1** **(1-18) 5**
proj-N	7.2 ± 4.7 (2-18) 8	8.8 ± 4.4 (1-29) 8.5	9.8 ± 4.6 (2-22) 9
proj-PR	3.2 ± 3.1 (1-12) 2	3.5 ± 2.3 (0-10) 3	3.9 ± 2.2 (0-9) 3

Mean values were compared with Kruskal-Wallis H test. Differences between pairs, with the Mann-Whitney U test

Values in the same row not sharing the same superscript (a or b) are significantly different at $p < 0.05$. Bold values indicate statistically significant differences

Tables 4 and 5 summarize the results of the univariate analysis of differences between the dependent variables' means across cluster membership categories. No significant differences among researchers in the different clusters were found for the number of articles per author in journals ranked in the first quartile of their subject category in the Journal Citation Reports (Art-Q1) and the number of funded projects as principal investigator (proj-PR).

The context where researchers participated in basic-clinical collaboration was associated with productivity in terms of WoS articles (Art-N) as well as with the number of participations in funded projects (proj-N) (Table 4). The highest productivity was shown by those researchers who worked in environments where basic-clinical collaboration occurred both within the host group and within the host hospital ‒i.e. those clusters whose first two digits are 1‒ But significant differences have just been found between the two ends of the spectrum, where the highest productivity is for researchers working in contexts of wide-ranging collaboration ‒i.e. cluster 111: collaboration within the host group and with other groups, either at the same or from a different centre‒ while least productive researchers are those for whom basic-clinical collaboration occurs together with other groups at the same hospital ‒cluster 010‒. Likewise, increased participation in funded projects was associated with wide-ranging basic-clinical collaboration. Researchers enjoying this collaboration environment participated in significantly more projects than the rest, with the exception of those who just experienced some intra-group collaboration (cluster #00), who were something in between the range of participations in research projects.

Researchers' self-perceived contribution to translational research was associated with productivity in terms of WoS articles (art-N), of WoS articles as the first or last author (art-FL) and of the most highly valued publications ‒which are those published in first-quartile WoS journals as the first or last author (art-Q1-FL). It was neither associated with participation in nor with leadership of funded projects (Table 5). Scientists in the 'low contribution to translational research' cluster published a significantly lower number of articles (art-N) than those with high contribution, with those characterised by medium contribution something in between. Disadvantage for the former is more evident when we consider art-FL and art-Q1-FL. In both cases, the number of articles published by individuals with low contribution to translational research is significantly lower than that of the rest of their colleagues.

Discussion

In this paper we analyse, in the particular setting of public hospitals of the Spanish NHS, to what extent full-time researchers with a mainly basic background improve their research performance and productivity as a result of collaborating with clinical colleagues and contributing to translational research.

Basic-clinical collaboration and involvement in translational research benefit scientists providing them opportunities for interactions with researchers in other disciplines and with clinicians, which can lead to new research opportunities, new projects, increased scientific output and faster publication rates (He et al. 2009; Hobin et al. 2012). A particular question that arises from our results is the extent to which involvement in basic-clinical collaboration may have different impacts on research performance and scientific output when distance and diversity are taken into account. Collaboration has been argued to increase with spatial proximity; but on the other hand, scientists sometimes tend to collaborate more with distant partners than with nearest colleagues (Katz 1994; Katz and Martin 1997). He et al. (2009) and Lee et al. (2010) tested empirically the relationship between proximity and scientific output, impact and quality, in two coauthorship-based studies of university biomedical researchers' publications. He et al. reported close (i.e. within-university) collaboration to be positively related to future (next year's) research output of scientists, but only distant (international) collaboration to be related to impact factor weighted and authorship adjusted research output; they did not find evidence of proximity being associated to increased impact and citation counts of publications, as they found that both international and within-university collaboration were positively related to the quality of a paper (as inferred from impact factor and citation counts). On the contrary, the research by Lee et al. (2010) provided evidence for the role of physical proximity of collaborators as predictor of publication impact (through citations). In our hospital-based study, spatial distance in basic-clinical collaboration was not found to be associated with performance and overall productivity of researchers, nor with their ability to publish in highly ranked international journals. Instead, increased scientific productivity and participation in funded projects as part of the team was shown by researchers having a more diverse and wide-ranging basic-clinical collaboration activity. That is, scientists who worked in a context where both basic and clinical research was done together with colleagues within its group as well as with researchers from other groups from either inside or outside their own hospital.

Contribution to translational research increases all quantitative indicators of scientific productivity and participation in funded projects, although we did not always find statistically significant differences. Principal (first or last) authorship of articles, and particularly of those published in first-quartile journals, has not been found to be related to the context where basic-clinical collaboration occurs, but associated with medium-to-high contribution to translational research. Thus, involvement in translational research not only increases overall performance and productivity, but also researchers' publication success, as it increases their scientific output as principal author in highly-ranked first-quartile journals. These results are consistent with the first of the theoretical reasons for positive relationship between research collaboration and scientific output proposed by He et al. (2009), according to which translational research results in output of assumed "higher quality than it would be otherwise" more likely to be published in highly ranked journals. Thus, although our results are not always conclusive from a perspective of statistical significance, they challenge the arguments by some authors that translational projects have more difficulties than basic proposals to be granted by funding agencies (Cripe et al. 2005; Joiner 2005; Hobin et al. 2012) and to be published in high–impact journals (Littman et al. 2007; Feldman 2008; Hobin et al. 2012).

Our results do not reveal any association of basic-clinical collaboration with leadership. None of the clusters identifying the different contexts for collaboration were found to be related with increased researchers' participation as principal investigator of funded projects, nor with publication of scientific articles as principal author. Moreover, although they are not conclusive, results point towards the existence of a positive relationship between leadership and involvement in translational research. In fact, participation in projects as principal investigator increases as it does contribution to translational research, and scientists reporting medium to high contribution published a significantly higher number of articles as principal author.

A deeper understanding is needed of how the incorporation into hospitals of full-time scientists with a basic research background, and the ensuing interactions between all actors involved in biomedical translational research, can help to promote research and increase research outputs at health care institutions. In this sense, a few limitations of the study should be noted, some of which lead to areas and questions for further research. First, particular caution is needed when interpreting the relationships between variables, as they are not necessarily causal. Moreover, the cross-sectional study here reported focuses on researchers' activity and outputs during the six-year duration of their programme contract. Thus, no further long-term benefits from basic-clinical collaboration and involvement in translational research can be here inferred. In this connection, some authors agree that although feedback obtained through short-term assessment is useful, identification and assessment of the scientific benefits derived from transdisciplinary and translational science requires a longer-term, multi-decade historical perspective (Stokols et al. 2003; Mâsse et al. 2008; Pozen and Kline 2011). In addition, the sample size may have prevented significant associations to emerge that could have appeared with a larger sample. A challenge for future studies is to increase sample size as new calls of the MS Programme come to their end. Moreover, it has been argued that although the relevance of team-based research is widely recognised, the present system of scientific evaluation and reward is mainly focused on rewarding individual accomplishment (Hörig et al. 2005, Pozen and Kline 2011). In the words of Littman et al. (2007:225), this "creates a conflict between the reward structure of academic institutions and the results that are actually expected of translational researchers". Our results show that translational research can improve individual performance, but it should be examined whether it may also improve it at the group level. Furthermore, in this research we focus on scholarly (academic) performance and productivity. But biomedical and health research should obviously have the final objective of translating results into innovations, applications, products and services aimed at improving patient care and the health of population. An exciting topic for further scrutiny is now whether translational research and collaboration between basic researchers, clinical researchers and health care professionals, hold the potential to increase the outcomes of biomedical and health research and contribute to improve their social impact.

We have discussed elsewhere (Antonio-García et al. 2014) recommendations for science policy which may be directly applicable to the MS Programme, as well as to hospitals and research centres affiliated with the NHS wishing to implement or develop a research agenda. We discussed the implications for science policy of a) investing in human resources for research, b) favouring actions that allow basic scientists to have closer contact with clinical research and with the hospital setting, and c) fostering researchers' involvement with health care and clinical practise, and ultimately with translational research. Furthermore, we pointed out the need of management and policy actions to be developed and refined in the light of knowledge gained from evaluations and informed by evaluations taking into consideration local needs and environmental conditions.

Results of this analysis suggest some additional recommendations. Basic-clinical collaboration and translational research should be an incentive for researchers as they are likely to favour their performance and productivity. Hospitals will benefit from encouraging researchers and health care practitioners to collaborate in the framework of translational projects, as a way to improve not only individual, but institutional research performance. Spanish hospitals should contribute to overcome obstacles to translational research, through the full integration of basic researchers within the hospital setting and the definition of a research career path within the NHS.

Conclusion

Basic-clinical research collaboration and involvement in translational research are somewhat beneficial for basic scientists incorporated to do research at public hospitals: they increase researchers' performance, by garnering them additional opportunities as team members of funded research projects, and improving publication in international impact journals. Collaborating with clinical researchers and health care practitioners may increase productivity of Miguel Servet researchers in hospitals. But the extent to which they are able to contribute to translational research is the factor that allows them to make a qualitative leap in succeeding as authors of articles in highly ranked international journals. Our results challenge the arguments by some authors that translational projects have more difficulties than basic proposals to be granted by funding agencies and to be published in high–impact journals.

In the framework of the Spanish National Health System, the full integration of basic researchers within the hospital setting and the definition of a research career path may contribute to facilitate collaboration between researchers and health care practitioners and to overcome obstacles to translational research. Opening doors to basic-clinical collaboration and translational research will improve not only individual, but institutional research performance.

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