

Focus on People and the Science Will Follow: Motivating Forces for Professional Movement in Stem Cell Research

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Abstract The migration of researchers across geographic borders, or “brain drain” as it is commonly called, remains an important issue for governments around the world as loss or gain of highly qualified personnel in research can have substantial social, economic and political consequences. In the present study we seek to examine the forces that drive international professional migration of stem cell (SC) researchers, for which variation of SC policy in different jurisdictions has previously been implicated as a driving force. Structured interviews were carried out with a purposive sample of SC researchers in the professoriate who had made international moves after postdoctoral work between the years 2001–2014, or were actively anticipating a future move. Participants were asked to rank motivators of international movement on a 5-point Likert scale and prompted to elaborate on their answers. The results suggest that career considerations, availability of research funding, and personal considerations are of high importance to the participants when considering an international move, while the permissiveness or restrictiveness SC research policy is of comparably lower importance. Participants also expressed that international movements are beneficial to scientific careers

overall. The findings have important implications for policy and strategies to attract and retain members of the SC research community.

Keywords Stem cells · Policy · Professional movement · Brain drain · Brain circulation

Introduction

Stem cell (SC) research has been celebrated for its contributions to science since the 1960s. Significant attention has been given to its potential to yield economic benefit and treatments for a wide range of serious diseases. Indeed, a focus on its clinical translation and commercialization has come to pervade funding agency mandates, government policy, and messages to the public through the popular press and the Internet. The potential of SC research is immense, and measured enthusiasm along with focused resources will facilitate the timely development of useful technology. In order for such progress to be realized it is essential to identify and address the complexity of the professional landscape alongside the trajectories of basic and translational research.

The movement of scientists and other professionals across geographic borders, commonly referred to as “brain drain,” is a significant concern for governments as loss of highly qualified personnel can have economic, political and social repercussions [1]. However, the movement of researchers, whether across institutions, within countries or across borders, may also reflect a desirable “brain circulation” that serves to fuel fresh thinking and healthy competitiveness [2, 3]. The literature suggests that this phenomenon, independent of its framing as a drain on local resources or as

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healthy circulation, is affected by a combination of factors ranging from country-specific cultural issues and language considerations to more technical factors such as taxation, immigration and research policies [4]. Japan's low intake of foreign researchers, for example, is thought to be a reflection of language barriers in this country, while in the United Kingdom (UK), liberal research policies entice researchers to move there [4–7]. SC scientists in particular have proven to be more prone to international job opportunities and to international moves than scientists in less controversial biomedical fields [8]. The movement of senior researchers in the field is particularly important as the departure or arrival of a key academic can alter the course of research in an entire geographic region [6]. In Singapore for example, a coordinated political, economic, ethical and scientific effort attempted to build a stem cell industry from scratch in the early 2000s, an effort that included the attraction of foreign established researchers [9, 10].

At present, policy aimed at addressing professional movement in scientific research is largely based on assumptions about factors that cause researchers to migrate. It has been suggested that funding and regulatory environments have a significant impact on the ability of a jurisdiction to attract and retain scientific talent [11]; however, these are likely only two of the many factors that affect movement decisions of researchers around the globe [12]. With the exception of studies focusing specifically on human embryonic SC (hESC) researchers in the United States (US), little empirical research has been carried out on the career choices of individual researchers [13, 14]. Here, we examine the forces that motivate SC researchers at the level of the professoriate to relocate, and the perceived impact of such moves on the individual and on research. We sought to identify the push and pull forces underlying these movements, and focused on the period between the US restrictions on federal funding of hESC research in 2001 and present day. While we used this window of time for its importance to the hESC arena in particular, we are interested in the unexplored movements of SC researchers more broadly.

Materials and Methods

Participants

An extensive database of SC researchers was created from publically available information including peer-reviewed literature, government grants, and institutional websites. Participants were recruited from the database and by snowball sampling to comment on forces that affected their past moves as well as future moves actively anticipated for up to 2 years from the time of interview. They were recruited by email invitation with reminders as

needed, and an interview was scheduled at their convenience. The corresponding author's research ethics board approved this study, and informed consent was sought from all participants prior to enrollment. Participants were required to be able to converse in English, and to be in the professorate, either junior or senior, tenure track or not, with approximately 20 % or more of their work time involving SC research. They also had to have made an international move of at least 12 months in duration after postdoctoral training, between the years 2001–2014, or be actively anticipating a future such move to be eligible to participate.

Interview Development and Data Collection

The interviews were designed to elicit and provide both quantifiable and descriptive information about why SC scientists move between countries and forces that underlie their decisions to move. The interview participants were asked to rank seven motivators of international movements [15], (Table 1) on a 5-point Likert scale (0: No consideration - 5 Decisive consideration), and were prompted to explain their choice in an open-ended response. Definitions of motivators were provided to assure clarity of terminology. Participants were also asked about whether the access to a specific type of stem cell was a motivator, collaborative links with their institutions before and after their move, and the perceived effects of the move on their career. The series of questions was repeated if the participant had made more than one international move within the allotted time period and/or was planning a future international move within 2 years of the interview. Participants were given the opportunity to make additional comments not probed a priori by the interview guide. These structured interviews were all conducted by telephone and were one-time, audio-recorded events with a target completion time of 30 min. Interviews were transcribed verbatim and made ready for software analysis.

Data Analysis

Descriptive statistics were used to analyze the Likert scale and other quantitative results. Open-ended responses were organized using NVivo 10 software (QSR International, 2012) and analyzed qualitatively using the principles of thematic analysis [16]. The narrative responses were carefully reviewed by a researcher trained in qualitative methods who developed a coding scheme through an iterative process that involves continuously revisiting and revising codes. A second trained researcher coded approximately 20 % of the transcripts to check reliability. Any discrepancy between coders was discussed until a consensus was reached, and the coding guide updated accordingly.

Table 1 Motivators for international moves ranked on a 5-point Likert scale

Motivator	Definitions and examples
Career considerations	Promotion, salary, working conditions
Personal considerations	Partner's career, children's educational opportunities, housing
Funding	Availability of competition for research funding
Public perception	Portrayal of stem cell research in the media, public opposition of stem cell research
Legal and regulatory factors	Provincial, state or national restrictions on research
Administrative environment	Frequency of reporting requirements, laboratory inspections, ethics committee or institutional review board
Opportunities for commercialization	Opportunities for commercial advancement and financial benefit beyond the academic setting

Results

Participants

A total of 28 SC scientists were consented and interviewed for the study. Participants were working in geographic locations that are SC hubs including Germany, the US, Canada, the UK, Singapore and Israel. All participants were affiliated with a

university. Interviews from eight participants were reserved for future data analysis because they did not meet the strict inclusion criteria regarding professional movement in the 14-year window of interest, with an $N=20$ analyzed in our final data set. Twenty-four moves from the 20 eligible participants were analyzed in total. Eighteen of these moves occurred before interviews took place, and are defined as *past moves*. Six moves were described as under serious consideration within 2 years of the interview are defined as *anticipated future moves*. Participant demographics are summarized in Tables 2 and 3. Three participants who spoke about *past moves* indicated that they used hESCs in their research; only one of these participants used hESCs exclusively. One participant who spoke about *anticipated future moves* indicated the use of hESCs along with other cell types.

Table 2 Participant demographics - past moves

Gender	<i>n</i>
Male	15
Female	3
Age range	<i>n</i>
30–40	6
41–50	5
51+	7
Current country of residence	<i>n</i>
Germany	5
United States	5
Canada	4
United Kingdom	2
Singapore	1
Israel	1
Move in Position	<i>n</i>
Postdoc-PI	10
PI-PI	7
MD Residency-PI	1
Move between Location	<i>n</i>
United States-Europe	5
Canada-United States	3
Canada-Europe	2
Europe-Canada	2
United States-Canada	2
Europe-Europe	1
Europe-Asia	1
Canada-Asia	1
Europe-United States	1

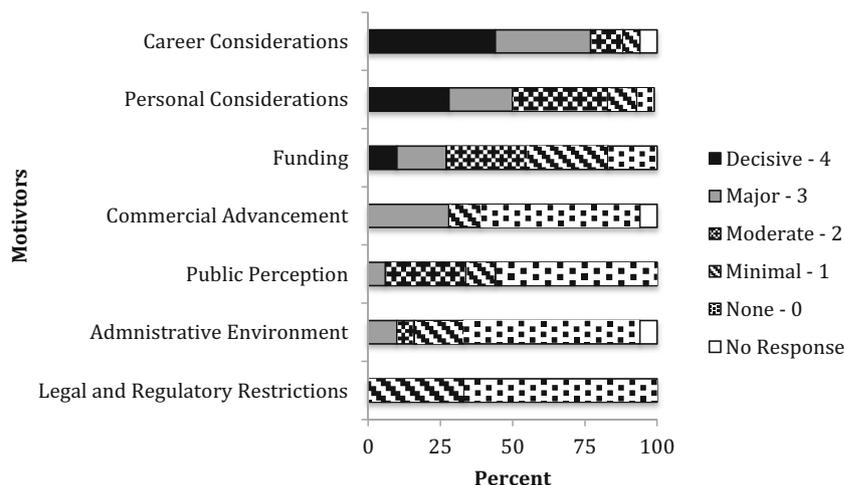
PI principal investigator, *MD* medical doctor

Table 3 Participant demographics - anticipated future moves

Gender	<i>n</i>
Male	6
Female	0
Age range	<i>n</i>
30–40	2
41–50	2
51+	2
Current country of residence	<i>n</i>
Germany	2
United Kingdom	2
United States	1
Singapore	1
Move in Position	<i>n</i>
PI-PI	4
Postdoc-PI	1
CL-CS	1
Move between location	<i>n</i>
Unknown	3
United States-Canada	1
Europe-Canada	1
Asia-Europe	1

PI principal investigator, *CL* clinical lecturer, *CS* clinical scientist

Fig. 1 Likert scale rankings of motivators for past professional movement



Past Moves

Analysis of the interview responses suggests that career considerations are the highest motivating factor for professional moves among participants interviewed (Fig. 1). Personal considerations and opportunities to apply for research grants were significant secondary motivators. The majority of participants ranked commercial advancement, public perception, administrative environment, and legal and regulatory restrictions as having no influence on their move considerations. Most (89 %) of participants said their move had a positive impact on their career while 78 % reported that they did not take the source of cells into account in considering their move. Most (83 %) also reported that they had no prior collaborations with the institution to which they moved (Fig. 2a). In contrast, 89 % of participants stated that they retained collaborations with their former institutions after relocating (Fig. 2b).

The narrative responses elaborate these findings. For example, with respect to career considerations, participants expressed that the opportunity for career advancement is an important factor when considering an international move:

“I was able to get the job here in Country A [withheld for confidentiality]...the job market was better here in Country A than [other countries] where it's much more saturated” (P25). Working in an intellectually stimulating setting was also a prevalent career consideration. As one participant explains: *“Moving here was an opportunity to immerse myself in a somewhat richer scientific environment” (P14).*

Personal considerations were mainly centered on family, such as education for children and career options for spouses. For example: *“Wanted to send [my kids] to school in Country B [withheld for confidentiality]” (P5),* and *“...my decision to move was based on the problems [my wife] was having with her career...” (P3).* The availability of research funding was also a main focus as

participants explained that they simply had to move where funding was available: *“...you cannot do research without funding” (P23),* and *“The funding that was offered to me when I moved was very good...also, the*

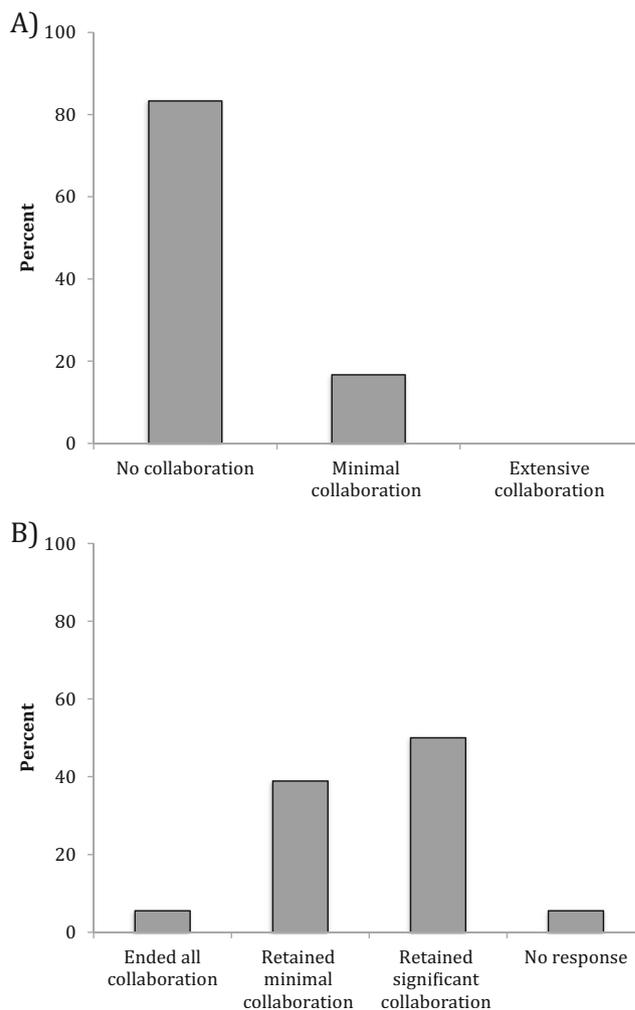


Fig. 2 a Institutional links prior to move (past moves). b Institutional links after move (past moves)

prospects for future funding...were higher...at the time I moved” (P6).

Participants also considered the role of commercialization possibilities for their research, however limited: “Commercial considerations have never been part of my landscape. I’m not an entrepreneur” (P18), and “I’m not particularly interested in commercializing my results” (P20).

Similarly, public perception was not a motivating factor for most participants. They reported that public perception is similar across countries: “I would say the public perception of the kind of research I do is similar in Country C [withheld for confidentiality] and Country D [withheld for confidentiality]” (P6), and “I didn’t anticipate it being different and it turned out to not be different” (P3). Some researchers also valued their scientific interest over the public’s perception of it: “I don’t care about other’s perception, and I research what I like...” (P4). Others did not take public perceptions into account because they felt that their work is not controversial and does not stir public opinion: “The kind of work I do was more below the radar maybe than some more obviously controversial work...” (P15), and “I don’t work with human embryonic stem cells” (P08).

Most participants simply did not consider the administrative environment, including ethics review and reporting, and explained that their research does not pose administrative challenges, or perceived the administrative environment to be similar in both the originating and destination location. For example: “...it’s not really relevant for my day to day...” (P20) and, in the case of one hESC researcher: “...both places had comparable...administrative environments” (P14).

Finally, legal and regulatory restrictions were generally not taken into account when making decisions about professional movements as most participants were not working with what they considered to be contentious materials. For example:

“...working with flies, it’s not a major issue for me” (P5), and “Very little, mainly because I don’t work on human stem cells...” (P6). In one case, however: “...I knew that Country E [withheld for confidentiality] is more liberal in their views towards embryonic induced pluripotent stem cell research and I considered it a plus” (P24). For participants who worked with hESCs, legal and regulatory factors were still of relatively less importance compared to other factors, for example: “...in Country F [withheld for confidentiality] there weren’t any severe restrictions on the type of research that I was planning on doing” (P14).

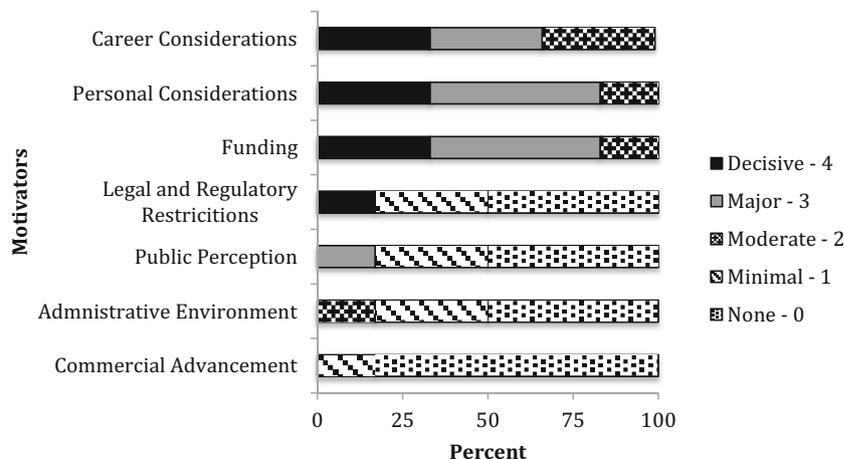
Past Moves of Junior and Senior Faculty

Our sample of past moves contained 11 moves by junior faculty (defined here as movements between postdoctoral fellow or medical doctor residency and principal investigator), and 7 by senior faculty, (defined here as moves between two principal investigator positions). We found that the trends in the data were largely consistent between the two groups for motivators. The most noticeable difference was for professional considerations where 72 % of participants who spoke about junior moves stated that it was a decisive factor. While 43 % of the more senior participants did consider professional considerations as a major factor, none stated that it was decisive per se.

Anticipated Future Moves

The majority of participants who were actively anticipating a future move ranked career considerations, personal considerations and research funding as decisive or major factors in their decision-making (Fig. 3). Commercial advancement, public perception, administrative environment, and legal and regulatory restrictions mattered little, similar to interview findings concerning *past moves*. These participants all anticipated

Fig. 3 Likert scale rankings of motivators for actively anticipated future moves



that an international move would have a positive impact on their career. None of these participants, including those who work with hESC, predicted that they would take source of cells into account. Many (50 %) also predicted that they would have minimal prior collaborations with their future institution before their move but would likely retain significant collaboration with their current institution if their international move culminated in the near future (67 %). The few participants who spoke about collaborations at a possible future institution mentioned that they had only minimal current activity with that institution, if any at all; they did, however, report that they would likely retain some or significant ongoing collaboration with their present institution if the international move were to be realized.

The narratives provide more detailed insight. For example, future moves were focused on promotions: “...I’m looking for tenured professorship” (P5), and “...the ideal job...that’s the reason to move” (P17).

Family considerations were again key: “The prospect of moving my family back to Country A [withheld for confidentiality] was very important” (P17). Quality of life was a new driver: “...characteristics of the cultural environment and the physical environment [are important] as well” (P6).

Future funding was a significant consideration for both research and job stability:

“...the funding opportunities in the different countries... that are geared towards stem cell subject research programs and basic biology are very, very important. And the likelihood of me as a new investigator getting those sources of funding is...a huge deciding factor” (P13), and “...it’s very simple, we just simply need a good amount of funding to do modern, cutting edge research at a reasonable level. And if not enough funding is available, then we wouldn’t move” (P6).

Discussion

In this study of movement among SC researchers at the professoriate level, we found that scientists place great importance on career considerations, personal considerations, and funding, and they retain links with their former institutions. They place minimal value on commercial advancement, public perception, administrative environment and legal and regulatory restrictions in this context.

The benefits of researcher professional movements, or “brain circulation” are being recognized as international collaboration is on the rise and laboratories are enriched by interdisciplinary and international teams of researchers [5]. Scientists who are mobile propagate valuable ideas and expertise, and form connections and collaborations that foster knowledge sharing. Such activities are vital for progress in science and for the advancement of

individual researcher careers [4]. Indeed an overwhelming majority of participants in this study perceived that their international move had a positive impact on their careers.

Previous research that has focused on motivators of professional movements of larger samples of hESC researchers found that policy is a major determinant of migration [13, 14, 17]. The policy environment surrounding SC research around the globe has been referred to as a “patchwork of patchworks” [18] with policies varying greatly across geographic borders that affect important aspects of research such as availability of funding, formation of collaborations and intellectual property rules. This policy patchwork is believed to greatly affect the mobility of hESC researchers; however, looking at SC research more broadly, researchers place considerably greater value on factors such as their personal lives rather than on the permissiveness or restrictions of research policy. Solving the “two body problem” [19] and the availability of programs for spouses and children of researchers to successfully adjust to life in a new jurisdiction are essential for attracting and retaining SC scientists. Alongside these considerations, funding cannot be a bottleneck in this domain of research, like others in the biosciences, where innovation and advancement are key and sufficient funds are simply needed for scientific progress. Our findings reiterate those of other studies that show SC scientists place a high importance on their intellectual environment including their access to collaborations [13] and that they tend to favour their own scientific interests over regulatory uncertainty [20]. Even the few participants in our sample whose work involved hESCs did not give policy high consideration. The findings show that it is a rich array of factors that affect professional movement of these scientists, and even those who may be highly affected by the policy patchwork take multiple factors into consideration beyond policy and the type of cells they work with.

Most policy aimed at attracting and retaining SC scientists is based on speculation about what motivates SC researchers to move internationally [11]. Some previous efforts to study researcher migration have relied on bibliometric methodology that uses publication data to track movement of and collaboration between researchers [5, 21]. While valuable, these studies lack the power to determine the reasoning behind researcher movement and collaboration, key components to consider when shaping policy [6]. The present study also has limitations that should be acknowledged. The cohort size is small and specialized to faculty-level SC researchers. However, past qualitative interview studies have shown that it is quite possible to reach thematic saturation with small homogenous samples and concepts tend to drop off substantially after approximately 10–15 interviews [22, 23]. We recognize that the uneven distribution of male versus female participants in the sample leaves us with lingering questions about gender-related trends. Given the small number of participants who moved in any given year, the findings of this study cannot be benchmarked to significant changes in SC policy, such as the Obama Administration’s lift on hESC funding restrictions in the US in 2009.

Nonetheless, a review of past literature that is largely focused on hESC researchers led us to predict that SC research policy would play the key role in professional migration decisions of professoriate SC researchers more generally. Our results suggest that when looking at the broader stem cell community, a larger set of complementary forces such as opportunities for personal and professional growth conspires to motivate professional moves. We also appreciate that the seven motivators of professional movement examined in this study are not mutually exclusive, and categories such as funding and policy for example are closely interconnected. For the purposes of this study, however, each motivator was defined as a separate entity and interplay between categories did not emerge as a major theme.

Considerations for the pursuit of career advancement and quality of personal life seem to surpass regulatory or public opinion in destination locations. Funding is a ubiquitous concern. Overall, professional circulation that is a natural feature of the biosciences is a feature of the SC community as well, despite much hype about brain drain associated with fluctuating government policies. Retention of ties with prior institutions and collaborators reifies this observation and conclusion. There is much to be gained by explicitly embodying these reflections and values offered from within the community into policy-making, research planning, program development, and strategies for recruitment and retention of SC researchers.

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Conflict of Interest The authors declare no potential conflicts of interest

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