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Understanding the new human genetics: A review of scientific editorials

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Abstract

Developments in genetics are expected to have a profound impact on health and health care, yet much remains to be learned about how leaders of the research and clinical communities view and frame these expectations. We conducted a comprehensive review of editorials about developments in genetic medicine published in scientific journals, to understand what this elite group of commentators anticipate. Editorials are an important resource for understanding how the new genetics is understood and portrayed. They allow leaders of the research and clinical communities to communicate to each other and informed publics, and are a forum for the expression of widely shared elite beliefs and opinions. We analyzed selected editorials for content and metaphoric language to explore attitudes and expectations concerning developments in genetic science and technology. Our analysis suggests that a diverse group of leaders of the research and clinical communities are remarkably uniform in their discourse about the future of genetic medicine. Editorialists have great expectations for developments in basic science and in the comprehension and management of disease. They also anticipate important effects on health care, notably the health care professions, and on wider society. Yet editorialists do not discuss these prospects in a consistently positive or optimistic manner, and they utilize metaphoric imagery that emphasizes the inexorable nature of progress, and the sometimes ominous manner in which developments emerge. The dominant discourse of editorialists claims authority for clinicians and researchers and asserts a broad sphere of expertise, but it also positions these leaders as handmaidens of a science they do not control, and insists that their ultimate contribution is to prepare themselves and others for the inexorable march of progress.

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Introduction

Developments in genetics are expected to have a profound impact on health and health care, yet

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much remains to be learned about how leaders of the research and clinical communities view and frame future prospects. We explore the claims made by clinicians and researchers in scientific editorials about genetics to understand what this elite group of commentators expect, and how they discuss these expectations.

Researchers and clinicians play an important role in shaping attitudes toward the "new human genetics" (Cunningham–Burley & Kerr, 1999, pp. 650–652).

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These "new genetics professionals," as Anne Kerr and colleagues (Kerr, Cunningham–Burley, & Amos, 1997, p. 280) have called elite members of this group, guide education and policy (Cunningham–Burley & Kerr, 1999; Kerr et al., 1997), and inform media commentary (Anderson, 2002; Bubela & Caulfield, 2004; Hansen, 1994; Petersen, 2001). Indeed, journalists rely heavily on well-known scientists and established scientific journals as news sources (Anderson, 2002; Bubela & Caulfield, 2004; Hansen, 1994; Petersen, 2001). Yet despite the importance of this elite community, there is a surprising poverty of evidence about their collective expectations for the future of genetic medicine.

Many social researchers have examined the popular media to understand how genetics is portrayed, and the role of scientists in influencing these portrayals (Bubela & Caulfield, 2004; Condit, Ofulue, & Sheedy, 1998; Conrad, 2001; Henderson & Kitzinger, 1999; Petersen, 2001). Others have talked directly to elite representatives of the profession, or reviewed scientific journal articles and other published texts (e.g., collected works) (Cunningham-Burley & Kerr, 1999), to understand how researchers and clinicians discursively frame developments in genetics, and their roles and responsibilities in relation to these developments (Kerr et al., 1997; Kerr, Cunningham-Burley, & Amos, 1998). We report on a comprehensive review of editorials about developments in genetic medicine published in scientific journals. Editorials are an important resource for understanding how the new genetics is understood and portrayed. Published in peer-reviewed journals, editorials allow leaders of the research and clinical communities to provide commentary on developments in science and clinical practice. They are a medium for researchers and clinicians to communicate with each other, and informed publics, and a forum for the explicit expression of beliefs and opinions. Unlike more polemical commentary sections in scientific journals, that exist to foster controversy and debate, and often provide a platform for "outsiders", editorials convey the more conventional views of the scientific leadership. We expected a diversity of opinion to be expressed in these pages, but that opinion would convey generally accepted positions, thereby providing a means to understand the expectations of dominant groups. We therefore analyzed selected editorials for content and metaphoric language to explore editorialists' attitudes and expectations concerning developments in genetic science and technology in health and health care.

Our analysis of scientific editorials suggests that a diverse group of leaders of the research and clinical communities are remarkably uniform in their discourse about the future of genetic medicine. Editorialists have great expectations for developments in basic science, and they adopt a predominantly determinist and reductionist interpretation of the impact of genes on disease, an etiologic logic that encourages similarly great expectations for developments in the comprehension and management of disease. Editorialists also anticipate important effects on health care, notably the health care professions, and on the wider society. Yet editorialists do not discuss these expectations in a consistently positive or optimistic manner. Further, they utilize metaphoric imagery that emphasizes the inexorable nature of progress, and the sometimesominous manner in which developments emerge. Though often leading the way, in a practical sense, these rhetorical devices suggest that clinicians and researchers are not in control of "the current revolution in genomics" [24], but rather, that they and their colleagues must "be prepared" [43]. The dominant discourse of editorialists regarding developments in genetic medicine claims authority for clinicians and researchers and asserts a broad sphere of expertise, but it also positions these leaders as handmaidens of a science they do not control, and insists that their ultimate contribution is to prepare themselves and others for the inexorable march of progress.

Data and methods

We sought to obtain a comprehensive sample of the full range of scientific editorials that reflected on the implications of developments in genetic and genomic knowledge for health and health care. We did not include other forms of commentary. such as comment sections and letters to the editor, which tend to be more polemical or idiosyncratic. Medline distinguishes between editorials, which are "a statement of the opinions, beliefs, and policy of the editor or publisher of a journal, representing the official organ of a society or organization," comment sections, which are "critical or explanatory note[s] written to discuss, support, or dispute an article or other presentation previously published" and letters to the editor, which are "communication between individuals or between persons and representatives of corporate bodies. The correspondence may be personal or professional"

(http://www.nlm.nih.gov/mesh/pubtypes2004.html). We conducted a literature search using the Medline (from 1966 to July 2003) and HealthSTAR (from 1975 to July 2003) databases (via PubMed), limited to English language, editorial publication type and human subjects. Keyword and Medline MeSH (Medical Subject Heading) searches for articles on genetics or genomics combined with technology, health, health care, management and delivery, legal issues, or medicine, with the limits identified above, vielded 186 results. A title search of these citations (by EH), to remove duplicates and articles outside our scope (i.e., not on genetic and genomic developments related to health and health care), left 89 articles for detailed review. CA and CS then reviewed all articles to remove those that were highly technical or narrowly focused on individual institutions or specific clinical implications. Only editorials from either scientific or clinical journals were included, and those from bioethics and social science journals were removed.



This search and selection strategy yielded a total of 77 editorials that were published in a wide range of high and low impact journals (e.g., 47 journals, with most of them represented by 1 or 2 editorials;

the journals with 4 or 5 editorials represented are *Nature Genetics, JAMA, Nature*, and the *American Journal of Medical Genetics*) from many parts of the world (mostly North America and Europe, but also India and Brazil). While our search strategy included a long timeline (over 25 years), most selected editorials were written in the last 8 years. Only 4 editorials were published before 1990, and 18 were published in the early 1990s. Thus, the majority of editorials (54) were published at the height of the "genomic" and "post-genomic" eras in health, beginning in the mid 1990s.

While we obtained a broad selection of journals and authors, this search and selection strategy has some limitations. Our search strategy was reliant upon the indexing decisions of individual journals, Medline and PubMed. Thus, some editorials and commentaries may have been misclassified by these institutions, resulting in the exclusion of some interesting and important editorial-like commentaries, and the inclusion of some more polemical commentary-like editorials. Further, in our efforts to review the full range of editorials (across all journals listed by Medline and HealthSTAR) while generating a manageable sample size, we used a range of keywords, MeSH headings and limits. Limiting the sample to the English language has an obvious biasing effect on the discourse detected, thus potentially restricting the relevance of our findings to the Anglo-American world. Also, it is possible that a different set of selection terms, or a more detailed review of the initial sample of 186 citations, might have produced a different final sample. Nonetheless, the selected editorials comprise a sample of available dominant commentary that is as unbiased (in the normative sense) and comprehensive as possible.

We conducted an interpretive analysis to identify editorialists' expectations and explicit value judgments about developments in genetics and its effects (Wolcott, 1994). Team members reviewed the editorials to identify salient quotes and concepts and to enter relevant editorial sections into an electronic database. A "domains" heuristic, established a priori (e.g., concerning science, disease and health, health care and health systems, and society) guided this search. After this initial review, CA and CS independently coded sections of editorials using NVivo qualitative data analysis software to identify emergent themes within the separate domains. An iterative collaborative process led to the refinement of the coding structure. Specifically, CA, FM and CS conducted a series of face-to-face meetings to discuss each theme or category until consensus was achieved on the appropriate coding domain. Following this, text within each of these coded themes was re-reviewed (by CA and CS) to isolate particularly explicit value judgments. The claims made within each domain, and their associated valuation, were then summarized in a memo for all team members to review and became the evidentiary basis of our substantive analysis.

We then conducted a metaphor analysis to understand how prospects for genetic medicine were conceptualized. Both CA and CS re-read all the editorials to identify and code any metaphors, with two exceptions. In genetics, some metaphors have become so pervasive that they have lost their figurative meaning and seem to be literally true. as with the notion of the genetic "code" or "map" (Van Dijck, 1998, p. 22). With the exclusion of these two terms, our search produced a total of 596 metaphors. We then focused our analysis on metaphors used to describe and discuss the four domains identified above (n = 191). CA, CS and FM held a series of face-to-face meetings to discuss and reach agreement about the inclusion, appropriate domain type, and analysis of each of these metaphors. Metaphors were discussed and included if they were, in fact, metaphors, and were related to one of the substantive domains, or excluded if they were one of those metaphors that are so pervasive as to have lost their meaning. We also discussed the purpose and meaning associated with each metaphor. Where possible, we confirmed or reconsidered our interpretation of metaphors listed in the Metaphors Dictionary (Sommers & Weiss, 2001). The metaphors in each of the substantive domains, and notes from related meetings, formed the basis of our metaphor analysis.

Metaphors offer a conceptual system that allows us to understand and experience one type of thing in terms of another (Lakoff & Johnson, 1980). Metaphors are used to illustrate and explain abstract concepts by linking them to more familiar objects or experiences; they help us to understand the original concept, but they also embellish it by attaching a new, implied meaning (Lakoff & Johnson, 1980). A metaphor "accomplishes in a word or phrase what could only otherwise be expressed in many words, if at all" (Sommer & Weiss, 2001, p. vii). Metaphors play an important role in the collective comprehension and interpretation of scientific concepts. For example, the image of the "instruction book" is profoundly reductionist suggesting that the whole can be understood as a collection of its parts. Charteris-Black (2004, p. 8) argues that metaphors are intrinsic to everyday language and reveal authors' implicit values and assumptions; conversely, Van Dijck (1998, p. 23) argues that scientists and journalist choose metaphors strategically to achieve a particular understanding of science. In our view, metaphors used to accompany scientific editorials may be chosen strategically, or reflect tacit beliefs about developments in genetics. In either case, they provide insight into the ways in which authors perceive and frame their substantive claims.

Findings

Scientific developments

Substantive: Editorialists have great expectations for genetic research. They argue that molecular genetic research has progressed rapidly, that future developments will continue apace, and that these developments, "will provide extensive new knowledge". [12] Major developments are anticipated, as "great practical benefit will accrue from this knowledge of the anatomy of the chromosomes" [60] such that "human cloning is inevitable" [44]. The editorialists are certain that "[s]cience and technology expansion will continue" [25], and "...that the advances of the next 7 years will be equal to, if not greater than, those of the past 7" [26]. Editorialists' explicit attitudes about developments in knowledge are largely optimistic: "The application of molecular genetic techniques to the study of disease is generating astounding advances in our knowledge of basic mechanisms" [19], emphasis added). Though some hesitancy is also voiced. It may, for example, take longer than predicted to achieve a full understanding of genetics: "[W]e are still grappling with the conceptual and intellectual tools to understand the interaction of multiple variables and have a long way to go" [8]. But such reservations address the limitations of current technology and incorporate the assumption that limitations will be overcome in time; they thus conform to the generally optimistic portraval of scientific developments. Yet this explicit optimism about developments in science is accompanied by more restrained metaphoric language.

Metaphorical: The dominant metaphoric imagery relating to developments in genetic science suggests

that genetic discovery is inexorable. Discoveries are presented as irreversible, having already altered our world, as inevitable, and immune to efforts aimed at stopping them, or as intentional, and thus governed by a clear determination to ensure continued progress. Some images of inexorable progress are fairly positive, including life cycle metaphors (i.e. "seeds" [51], or "infancy" [45], or the personification of genetic science as an explorer or wayfarer that has "crossed into new territory" [20]. But the imagery can be more sombre. Scientific developments are imagined as threatening forces of nature (e.g., a "spurt" [19], or "avalanche" [6] of discoveries). War metaphors are also used, with scientific developments imagined as relentless invading armies or artillery fire, as a "barrage of gene discoveries hits us on a daily basis" [28]. Some editorialists turn to the classic metaphor of "Pandora's Box" [55] to portray genetic science and technology as a somewhat dreaded and mysterious force or entity. A minority use less destined imagery for genetic discoveries and portray developments as a lifting "fog" [15]. These images are still suggestive of inexorable progress, though they are less emphatic, with only a few metaphors contradicting this sense of certain progress, by suggesting there is "a lot [of genetic information] to sift through" [49] before discoveries can be made, and that scientific discovery is akin to "whistling in the dark" [15]. Images of inexorable progress in scientific knowledge are dominant, though not always positive. They suggest that scientific development is propelled by a clear logic and momentum and imply that this inexorable force will have predictable effects on health and disease.

Health and disease

Substantive: Many of the expectations that editorialists express for the development of new scientific knowledge are repeated in reference to health and disease. Editorialists anticipate the ready translation of scientific knowledge into clinical capacity. They anticipate that knowledge about genetic processes will result in an increasing ability to understand disease (i.e., focusing on the "cause" not the "symptoms" [38], permitting more accurate systems of disease management and classification and improved health. Specifically, editorialists predict the rapid development of genetic risk assessments for adult-onset conditions, and the availability of therapies such as gene therapy:

"... we will see the first successful examples of gene therapy and the first development of corresponding protocols" [3]. They also predict that preventive and personalized treatments might result in "the design of individually tailored therapies that are based on genetic risk" [7]. Indeed, some editorialists are optimistic enough to predict that the "hope for eradication of entire disease classes is within the range of possibilities in the near future" [25]. In addition, editorialists anticipate developments in the way in which diseases are categorized and classified, and thus defined. Diseases that have no obvious connection, for example, might be linked by the identification of a common genetic factor (e.g., Sudden Cardiac Death and Sudden Infant Death Syndrome, [30]. Alternately, a disease that previously appeared as a coherent and singular phenomenon might be divided into multiple categories, even to the extent of individualizing the disease (e.g., Mrs. Jones' vs. Mrs. Smiths' diabetes, [17]).

The expressed attitudes toward anticipated developments span a full spectrum, from positive to negative. Comments range from the unreservedly positive, that the "exciting possibility" [38] of genetics "holds great promise" [17], through the reservedly positive, indicating that developments "hold out hope" [8] for novel prevention, diagnosis and treatments. Other editorialists are more cautionary, warning that the link between gene discovery and treatment development remains tenuous, and that potential improvements are "a distant and uncertain prospect" [40]. Such cautionary statements identify limits in the extent to which genes cause disease: "...chronic illnesses are complex systems. Genetics only describes part of the variation" [17].

Metaphorical: Despite some reservations about the role of genes in disease, the imagery evoked by editorialists suggests the ultimate ability of genetic science to decipher etiologic processes. As Petersen (2001, p. 1261) has suggested in relation to the popular media, the imagery used to illuminate the genetics of disease often has a mysterious character, implying that underlying molecular processes await scientific revelation. In this vein, many editorialists use images that convey a somewhat opaque process for comprehending the role of genes in disease: truths will be "pinned down" [33], [49]; clarification might come by "dissecting" [4] or "unravelling" [49], [33], [51]. Other metaphors relating to health and disease are more classically mechanistic, suggesting a "molecular circuitry" [50] or "molecular toolkit" [20]. Both sets of images suggest that disease cause is ultimately knowable, given time, with only one metaphor contradicting this overarching expectation by comparing searching for etiologic explanations to chasing a "will o' the wisp" [13].

As with the images associated with scientific discoveries, metaphors associated with the creation of novel diagnostic and treatment options suggest that developments in understanding and managing health and disease are inexorable. The genetic technologies themselves have undergone "quantum shifts" [36] and are portraved as genies that cannot be put "back into their bottles" [3]. Consideration of the "fast and furious" [34] impact of genetic technologies on health sometimes involves mechanistic images: genetics will give physicians "new tools" [29] to "tinker with at least some genetic traits" [8]. In this vein, scientists are like locksmiths and can "unlock the passageways" [30] of disease causation, suggesting that it will be possible to simply remove or "snip" the "bad" genes [17]. Militaristic metaphors are also evident: the impact of genetics is akin to an "explosion" [34], or a "propelling" [3] force that is part of an "ongoing invasion of medicine" [3]. Alternately, genetic technologies seem to act as forces of nature: genetics has "spawned" [24] new health technologies, and will "trigger a flood" [8] of new pharmaceuticals. In addition to these inevitable or irreversible images, some authors use metaphors that declare a clear intention to use genetics to modify health and disease; they promise to "pursue the road" [3] from gene analysis to applications in health and disease, or insist that genomics should be "maximally mined" [54] to this end. A minority of images contradict this prevailing sense of inexorable progress, suggesting that claims of a direct impact of gene discovery on treatment options and capacity are "distant and uncertain" [40] since "hidden among these simple statements lurks great complexity" [4]. On balance, however, editorialists expect great things of genetics in the domains of science, health and disease, and they select metaphoric imagery that emphasizes the inexorable, if sometimes dark, nature of such progress.

Health care systems

Substantive: As is the case for the other domains, editorialists have high hopes for the impact of genetics on health systems, but they express

considerable concern about how such developments might be managed, and select metaphors that highlight this ambivalence. Many editorialists expect a significant impact on health systems, as genetics "increasingly permeates all areas of medicine" [65], and foresee a "shift towards a genetic paradigm in healthcare ... " [16]. Indeed, editorialists are generally optimistic that these developments have the capacity to improve the effectiveness and efficiency of health care, and specifically, that the preventive orientation might lead to "a reduction in health care costs over the long term" [20]. Yet editorialists express concern about the ability of the health care system to manage developments in genetics, since technology availability "does not guarantee the proper and timely use of the information" [12]. They call for both health policy-makers and health professionals to adequately prepare for anticipated developments: "in realizing the benefits of genetic testing in disease prevention, physicians and policy makers must establish mechanisms to evaluate and respond to the implications of new genetic information as soon as it becomes available" [42]. Genetic knowledge, they argue, is "urgently needed for the development of medical and public health policy" [28].

In addition to expecting change in the orientation and outcomes of health care, editorialists anticipate major changes in the practices and training of health care professionals. Indeed, the ambivalence conveyed by editorialists relates to the expectation that virtually all health professionals will be affected by developments in genetic knowledge and capacity: "all specialists will have to become familiar with the genetic factors underlying the diseases they see" [4]; see also [7]. Health care professionals of all persuasions will be faced with continually changing "concepts, [and] treatments... that literally reshape our professional identities and responsibilities, almost from week to week [38]. Editorialists express concern that the "typical busy clinician... is probably not thinking much about the role of genetics in the patient's problem" [21]. They admonish their colleagues to prepare - to "appreciate the threats to the status quo" [17] — and offer advice on how to do so: for example, "allergists should become better phenotypers by accurately establishing atopic status and disease severity status of their patients, so that when genotyping becomes a routine clinical reality, they will be prepared to use this unique tool for appropriate diagnostic and therapeutic interventions"

[43]. Yet many editorialists doubt whether attempts to prepare will be successful. They are skeptical of the ability of health professionals to "keep up with" [19] a genetic orientation in medicine, and suggest that, "those who provide health services will be unable to distinguish between hyperbole and reality" [24]. "How can a small cadre of genetic nursing experts," one editorialist asks, "facilitate national recognition and value for the impact of genetics on nursing practice...?" [16]. These ambivalent attitudes toward the impact of genetics on health systems, and especially health professionals, are further illustrated by the metaphoric imagery chosen by editorialists.

Metaphorical: As with the images used to illustrate developments in science and the management of disease, the metaphoric imagery associated with changes in the health care system conveys a sense of inexorable progress. Images are suggestive of sweeping and fundamental changes, such as a genetic "revolution" [56] in health care. Naturalistic metaphors imply that developments inspired by genetics are part of the natural history of health systems: the "birth of genomic medicine" [51] produces a "changing landscape in health care" [17] in these "fast-moving and turbulent times" [57]. Yet not all of the images evoked by editorialists are benign, as genetics is also conceived as a "cutting edge" that is "invading the mainstream" [20] of a "broken" [49] health care system. The metaphoric imagery used to illustrate discussions about the impact of genetics on health professionals is even more ominous. Health professionals are enjoined to prepare for developments in genetics as for a storm, since change "hits us [health professionals] in overlapping waves with such force" [38]. Militaristic imagery is also used, and while it sometimes portrays professionals as "stand[ing] ready and able" [16], professionals do so in order to ensure their "survival" [16] knowing that keeping up with innovation "is a losing battle" [25]. All but one metaphoric image suggests that health care professionals are on the defensive and must accommodate themselves to developments in genetics. The sole positive image suggests that the "marriage" [34] of genetics and health will "usher in a golden age" [34] for public health practice. In general, editorialists anticipate that developments in genetics will have significant impacts on health systems, though they express concern about the ability of the system to manage these developments, and the ability of their colleagues to adapt to change.

Wider society

Substantive: Many editorialists extend their comments beyond the laboratory and the clinic, to the effects of developments in genetics on the wider society. In particular, editorialists identify a range of social and ethical implications of developments in genetic science and technology, and comment on public attitudes toward these developments. They discuss the classic ethical, legal and social issues (ELSI) in genetics, namely, that developments in genetics might negatively affect individuals and groups by invading privacy and enabling discrimination or stigmatization: "Issues of confidentiality, stigmatisation, and misuse of genetic information are high on the list of concerns, with the potential for creating a genetic underclass, denied medical insurance as a result of genetic testing and screening" [24]. Some editorialists express concern that a "series of social problems, including stigmatization, unfair discrimination, and uninformed decision making, might arise from increased availability of genetic information" [39]. Further, editorialists criticize a "misguided desire to play God" [55], and anticipate broad debate about contentious issues, such as selective abortion due to prenatal screening, or stem cell research: "this will all be accompanied by a worldwide debate on how we apply our knowledge from genetic research if it provides us with the possibility to interfere with germ lines and to use embryonic stem cells for new therapies" [3].

While the social commentary can highlight typical ELSI issues, and attribute possible social harm to developments in genetic science and technology, editorialists also suggest that society itself is to blame for whatever ills befall us. Social harm arises, in these commentaries, from the failure of various key social actors or institutions, or of the public itself (as expressed through public opinion), to respond appropriately to opportunities and threats. These editorialists argue that governments and lawmakers alone are not equipped to deal with these challenges since "...any attempt to control science by jurisdiction will fail unless the scientific community is engaged in the process" [46].

One type of harm is caused by the failure of social institutions to adequately protect the public against misuse, such as the possibility "that genetic data might be used for purposes other than those for which they were collected" [46]. Another form of harm derives from the public itself, because "Islocietal attitudes are fickle" [44], and public anxiety merely expresses "fears, prejudices and sometimes, neuroses" [3]. Editorialists argue that excessive public expectations and inflated hopes result from "media hype" [53], and detractors who have led the public to be unnecessarily fearful and skeptical of "genetic research and what it might lead to" [19]. Negative public expectations may lead to excessive criticism of genetics: "The scientific hubris and resulting chaos portrayed in Jurassic Park, the history of the eugenics movement in America, the Nazi racial purification schemes which culminated in the Holocaust, and the anti-gene therapy stance of Jeremy Rifkin have all had a negative influence on public thinking..." [26], or "...could create a considerable backlash against research if expectations outpace accomplishments" [37]. In addition to the social harm that derives from social inaction or public attitudes, a final form of social harm derives from overzealous attempts to regulate developments in genetics, such that increased "...legislation is eroding people's confidence" [36].

Whether social harm derives from science and technology, or from a failed social response to scientific developments, editorialists express concern about the impact that social issues might have on their research since "...science on the grand scale where it is developed and funded today can depend greatly on political and public opinion" [3]. Editorialists warn that public perceptions that "certain genetic findings are over-interpreted and, more poignantly, that the moral laxness of the past is treated meekly, with some equivocation and without perfect unanimity, may imperil our field's future" [44] and further that, "the misuse of genetics and the past corruption of science by politics have been major blows to the development of modern gene technology" [74]. Editorialists suggest remedies that reflect the diverse sources of negative impacts. Some opine that negative effects of the technologies could be mitigated by those with ethical, social scientific or clinical expertise, as a "safeguard against abuse" [27]. Others call on their peers to "protect the public, not only from disease, but also from alarmists and profiteers" [42]. Finally, some editorialists doubt the need for concern for "the patchy state of privacy protection" [36] and suggest that "zealous regulation is unnecessary" [58].

Metaphorical: The metaphoric imagery associated with the wider social impacts of genetics (and the social management of genetics) is predictably anxious, whether faulting science or society for the

negative implications of developments in genetics. The harms produced by genetic science and technology are described as "haunting the genetic landscape" [32] or "encroaching" [44] on ethically questionable practices, such as human cloning [44], and threatening to create a "genetic underclass" [24]. Naturalistic metaphors suggest that genetic developments might "spawn" [42] ethical problems that will "spill out of the laboratory" [3], while militaristic metaphors suggest a war, with ethical guardians "tackling difficult questions" [3] and "struggling to keep up" [34]. Alongside these forbidding images of the dangers of genetics itself, are a set of metaphors that illustrate the inadequacy of governments and ethicists to effectively respond to social challenges. Public institutions have moved along a "bumpy course" [3] and engaged in "battles" [8] to achieve consensus over privacy and patent laws, and an appropriate social response to who owns and manages genetic technology. This struggle has put society in a position where, like a poorly steered ship, we are in "danger of drifting into a position where genetic data becomes the property of the few" [59] — an outcome that might "paralyze" [6] some research studies. More ominously, some social institutions have "meekly bowed" to the "pressures" of a "knee-jerk response" [28] and engaged in over-regulation. Ethicists, politicians and governments may have inadequately "grappled" [39] with social impacts or are simply avoiding these "traditional hot potatoes" [58]. The culpability of these social actors is dramatized with tribal metaphors, suggesting that negative public opinions "are fuelled by the 'drumbeat of government and ethicists" [36], and that the "hue and cry over [the] lack of legislation magnifies the risk of abuse" [36].

Discussion

We set out to review a full range of scientific editorials addressing the implications of developments in genetics and genomics for health and health care, expecting that editorial discourse though mainstream — would be internally heterogeneous. Yet despite the diverse range of journals, subject matter and audiences represented in this sample, there is a surprising homogeneity in the way that editorialists discuss their expectations. Further, the types of claims and metaphors do not correlate with any obvious categories, such as journal type (i.e. clinical or scientific), or focus (i.e. general medicine or specialist).

Editorialists have great expectations for genetic medicine. They anticipate large gains in scientific knowledge, significant improvements in clinical capacity, demonstrable impacts on the health system, and identifiable repercussions for society as a whole. Their claims are extravagant, and their attitudes toward science and disease are generally positive: scientific advance moves at an "astonishing" pace, with therapeutic advances proceeding inexorably from new scientific knowledge. Editorialists are confident that therapeutic advances are "opening up a new world of medicine" [40] that will profoundly affect disease prevention and management, and they use metaphoric imagery that highlights the deterministic and reductionist way in which developments in science translate into improved explanatory and treatment capacity.

Editorialists are equally convinced that genetics will have an impact in the domains of health care and the wider society, but they are less sanguine about these impacts. The health care system, and the health professionals who staff it, must accommodate themselves to developments. Accommodation is necessary, some editorialists suggest, to ensure professional survival, but it is not certain that all professionals will be able to manage the onslaught. Further, editorialists are skeptical of the capacity of health systems to appropriately respond to the impact of genetics. Outside the laboratory and the clinic, even more pessimism prevails. Alongside the "officially sanctified ELSI" [8] commentary that highlights the potential negative social and ethical implications of genetics itself, is a sustained complaint about the social failings that exacerbate or create negative repercussions. Editorialists place blame for negative social impacts at the feet of governments, ethicists and the public itself, for failing to act, or for over-reacting, thereby constraining the progress of genetic science and causing social harm.

Alongside the explicit claims-making, another more implicit set of claims is apparent. Editorialists rely on a range of metaphors to suggest the *inexorable* nature of developments in genetics, and of the consequences of these developments in other domains. The "genetic revolution" is coming, the editorials suggest: it cannot and should not be stopped. In writing about developments in genetics, then, editorialists present a rhetorical contradiction, one that Anne Kerr and colleagues have highlighted

in their work on the new human genetics professionals (Kerr et al., 1997). On the one hand, editorialists make authoritative claims about the developments and implications of the new genetics. addressing a wide range of subjects, many of which extend beyond their areas of expertise. In doing so, editorialists position themselves as experts who can predict developments, and provide guidance for their peers, for health care systems, and for society at large, in appropriately managing and using genetic knowledge. On the other hand, editorialists portray developments in genetics and genomics as an inexorable force, for whose pace and direction they bear little responsibility: science advances, disease etiology is revealed, treatments are developed and health systems are changed, and where negative social impacts occur, society itself is often to blame. The editorials are characterized by a distancing from, and negation of, the editorialists' own agency in the creation and control of this knowledge: the imagery of inexorable change directs attention away from how scientific and technological development is advanced and the particular shape that it takes. Though the editorialists are arguably the creators of new genetic knowledge, and the managers of its implementation, the imagery that accompanies their commentary denies that power.

The representation of genetic medicine in scientific editorials is similar, in many respects, to portravals in the popular media. This is an unsurprising finding, given the reliance of journalists upon scientific sources (Bubela & Caulfield, 2004; Hansen, 1994). Like the grand and largely positive claims about scientific developments that we identified in the editorials, the popular media gives prominence to hopeful announcements about genetic discoveries, while downplaying subsequent disconfirmations (Benelli, 2003; Bubela & Caulfield, 2004; Conrad, 2001; Henderson & Kitzinger, 1999; Petersen 2001). Indeed, Conrad (2001) suggests that an "optimistic frame" best captures the public representation of genetics, and Petersen (2001) describes commentary in the news media as "biofantasies". Yet not all popular commentary is positive. Petersen (2001) argues that expressions of fear and uncertainty about the repercussions of "tampering with nature" are present, and serve to "draw the line" between "good" and "bad" scientific practices and prospects (p. 1265). Similarly, the editorials contain minority commentary that, while muted, is negative and cautionary. Such commentary doubts the hopeful predictions, or highlights the negative consequences. But editorialists do not limit their negative discourses to the science, and some of the metaphoric imagery they use places a negative gloss even on positive progress. Editorialists consider the repercussions of developments in science for the health care system, and express considerable anxiety about this domain. Further, they articulate a sustained critique of social attitudes and practices, with media "hype" as a key focus. In short, leaders of the research and clinical communities in genetic medicine rehearse their rights and responsibilities in complex ways. The "genetic optimism" present in popular commentary is not fully replicated in scientific discourse.

In a series of articles, Anne Kerr, Sarah Cunningham-Burley and Amanda Amos (Cunningham-Burley & Kerr, 1999; Kerr et al., 1997, 1998) have argued that the new human genetics professionals create discursive boundaries to position themselves as authoritative "experts" in genetics while eschewing responsibility for the effects of genetics. Further, these discursive boundaries focus attention on the fact of scientific development in genetics rather than the practices that produce it. Scientists and clinicians do not speak with one voice on these issues, but even internal critiques and "minority discourses" (Cunningham-Burley & Kerr, 1999, p. 658) focus attention on the implications, generally positive, of genetic science and technology, and draw attention away from the ways in which scientific discoveries are produced. Our research supports this analysis, but we offer new insights into the discourse of the new human genetics professionals.

First, our analysis highlights the breadth of the claims made by these elite commentators. Where Kerr, Cunningham-Burley and Amos focus on the role assumed by leading scientists in relation to social impacts (Cunningham-Burley & Kerr, 1999; Kerr et al., 1997, 1998), our findings suggest the equally important role assumed by genetics professionals in admonishing their peers and preparing health systems. Second, where Cunningham-Burley and Kerr criticize the new human genetics professionals for a narrow and "bland" (Cunningham-Burley & Kerr, 1999, p. 652) commentary on potential negative social and ethical implications of genetic developments, such as privacy issues and the potential for discrimination in insurance and employment, our analysis indicates a parallel and more combative critique. Our review of editorials

indicates that though the "ELSI" commentary is both present and predictably "bland", it is accompanied by a commentary that places the blame for negative social impacts squarely at the feet of key social actors and institutions, namely, governments, ethicists and public opinion. Not all of the criticism is consistent — laws might be too lax or too rigid, the public might expect too much or too little — but it effectively distances the human genetics professionals from responsibility for any ill effects, even as it extends their authority into these domains.

Finally, where the work of Kerr, Cunningham-Burley and Amos highlights the importance of discursive strategies, our work has examined both explicit claims-making, and the more subtle implicit or strategic use of metaphors. Metaphors are crucially important figures of speech, giving meaning to otherwise obscure concepts, and guiding the speaker and reader in adopting a shared set of images and affect. Though many different metaphoric images are selected by editorialists, most offer an image of inexorable progress to convey the nature of development in genetic science, technology and medicine: change is inevitable, irrevocable or subject to clear intention. Further, while some of the imagery associated is naturalistic, suggesting inevitable progress without negative overtones, much of it is sombre or ominous, portraying inevitable progress as something akin to an onslaught. Such metaphoric imagery supports both grand claims of change and a subtle distancing from responsibility.

Conclusion

We conducted a comprehensive review of editorials in scientific journals to understand what leaders of the research and clinical communities expect of developments in genetic medicine. We sought a broad range of editorial commentary, to gain insight into the mainstream opinion of leaders of the scientific community. We analyzed editorials for substantive claims, expressed attitudes and metaphoric images. In general, editorialists make grand and hopeful claims about developments in genetic science and technology, and anticipate significant impacts on the understanding and management of disease, the organization of health systems, and the operation of the wider society. The metaphoric imagery selected by editorialists to accompany their commentary supports and extends these claims,

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suggesting that progress and change are inexorable, if not always welcome.

A diverse range of editorialists offer a complex but consistent discourse about the future of genetic medicine and their role in it. The confidence of their predictions, and the wide-ranging nature of their commentary, insists upon the broad scope of their expertise and authority in contemplating genetic developments. At the same time, the metaphoric imagery of inexorable progress, and the sombre nature of much of this imagery, suggests that these leaders are not fully responsible for whatever may come to pass. Arguably, however, as leaders of the research and clinical communities, editorialists are creators and managers of the new human genetics. Their expertise cannot be divorced from responsibility. The resolution of this paradox may come from recognizing that these scientific leaders are neither all knowing nor fully responsible for the future of genetic medicine. That future is better considered and managed in more democratic ways.

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