Oral health policy: International implications for Australia

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The authors wish to honour the extraordinary life and work of Dr. Erica Bell and her drive in having this research undertaken. Erica published over 100 academic research papers and five books during her 10 years at the University of Tasmania, as well as publishing two historical novels. Erica is remembered by her family, friends and colleagues as a warrior of creative thought through her positive attitude, her all-encompassing love of life and her outstanding achievements.

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Background

The worlds of researchers and of policy makers are completely different. With apologies to John Gray, it could be said that “researchers are from Venus and policymakers are from Mars.” It summarises in one sentence what has been called the two communities theory [1,2,] which posits that the producers and users of knowledge live in separate worlds with different and often conflicting values, different reward systems, and different languages. Researchers all too often produce high quality research which is simply not used by policy makers. Policy making has traditionally been conducted by professional organisations, the private sector and government. One way APHCRI has gone about breaking down these different world views is by establishing Centres of Research Excellence, one of which is the Centre of Research Excellence in Primary Oral Health Care.

Analysis of how policy is formed is a very small research area within oral health. Only a small set of papers have analysed the problem of evidence translation and largely focus on evidence-practice translation[3]: Improving the translation of evidence from clinical trials[4], clinical guidelines[5,6] and for specific challenges, such as women’s oral health[7].

Until this research, no studies existed on whether oral health evidence influenced policy. Between 2000 and 2012, at least 127,193 unique papers with abstracts were published in oral health, but it had not been systematically analysed for its content relevance to oral health policy priorities. A Health Policy research indicates that the relevance of research *content* to policy may be more important than research methodology in policy take-up of research[2,8-11] than using the quality hierarchy dominated by the ‘blue chip’ standard of randomised controlled trials.

This study described the conceptual content of the entire corpus of oral health research abstracts 2000-2012 and compared it to the content of national oral health policy documents so as to build understandings of the nature of the evidence-policy divide so that research can better serve policy efforts to address oral health inequity.

Methods

We used Leximancer which is semantic analysis software developed at the University of Queensland, Brisbane in 2001 (https://www.leximancer.com/). Leximancer is a Bayesian-based application of computational linguistics in which 'machine learning' methods are applied to the analysis and synthesis of language. The specific method involved the comparison of two different samples. The first sample was 127,193 oral health abstracts published from January 1, 2000 to December 31, 2012, treated as indicative of all oral health research, obtained for this study. The second sample was eight national government oral health policy documents from eight Organisation for Economic Co-operation and Development (OECD) countries, published between 2004 and 2012, obtained in our previous study. A quantitative content analysis was performed using Bayesian-based, computational linguistics Leximancer software to describe the changing content of oral health research, by year, from 2000-2012. This was compared with the results of the same procedure for analysing the content of the eight policy documents. The section that follows draws upon the description of this method the authors have published in other computational linguistics studies.

RESEARCH AIMS

The aim of the study was to answer the following research questions,

- How well matched is the content of research to national oral health policy?
- What are the implications of this for developing oral health research that is more policy relevant, particularly for the challenge of addressing unequal oral health outcomes?

ORAL HEALTH LITERATURE SAMPLE

The oral health abstracts were obtained using search terms in the database Scopus as follows: "oral health" or "dental" or "dentist" or" periodontal". The terms were developed in discussion with oral health clinical co-authors to avoid the systematic exclusion of a large corpus of oral health literature. The sample of abstracts was designed to be sufficiently large and the findings sufficiently broad so as not to be substantively different with the addition of more specific words.

In relation to the database Scopus, the available evidence suggests Scopus offers 20% more coverage than Web of Science, PubMed being better for biomedical sources, and Google Scholar being less accurate.[12] Scopus is therefore the largest abstract and citation database of peer-reviewed literature in the world, including for all countries in this study. Yet the study is not a review of databases but rather an analysis of one highly authoritative database. The period searched was January 1, 2000 to December 31, 2012 to allow for a reasonable lag time of translation of research into evidence i.e. given the earliest date for the policy sample is 2004**.** The results were exported as CSV-format files in manually set batches of 2,000 abstracts (a download limitation of Scopus). The downloaded abstracts were subsequently added to a SQLite database for the purpose of generating CSV files with abstracts for a full year. This procedure involved manual checks of data consistency and removal of duplicate abstracts. Table 1 provides the number of abstracts published by year for this sample of 127,193 abstracts.

***Table 1**: Number of oral health abstracts, by year*

Year	No. of abstracts
2000	6,073
2001	5,624
2002	6,566
2003	8,417
2004	9,504
2005	10,084
2006	10,153
2007	11,125
2008	12,057
2009	11,714
2010	12,127
2011	11,570
2012	12,179
Total	127,193

ORAL HEALTH POLICY SAMPLE

National oral health policy documents published between 2004 and 2012 were sought. They came from Wales[13]; the USA[14]; Northern Ireland[15]; New Zealand[16]; Canada[17]; England[18]; Scotland[19] and Australia[20]. National policies were chosen in order to have consistency of context for the policy being made, although the authors accept that some provinces/states are as large as some countries. Our future studies will include policies from provinces/states as a distinct genre that share features as sub jurisdictional documents. The policy documents, like the abstracts, were treated as indicative evidence, i.e. of national oral health policy understandings, not necessarily what has been implemented. We defined a national policy statement, as,

- "current statements in English (not in languages other than English unless an English version of the statement is also available);
- statements by government agencies (not health professional associations or other organisations);
- explicit policy guidelines and planning statements, such as oral health plans, strategies and vision documents (not oral health implementation or activities reports or indicators for oral health system performance or policy recommendations in oral health research reports etc.);
- national (not international, multi-country, state or provincial) policy statements; and
- 'stand alone' oral health policy documents (not general health policy documents or health policy documents with a single oral health section)." [authors TBA]

These criteria obtained a total of eight documents yielded by searches of the websites of agencies in 34 OECD countries and follow-up queries for publicly available documents. Non sovereign countries, i.e. of the United Kingdom, were included as were draft documents[13] (WG 2012) if they met the sample criteria. Snowballing techniques scrutinising the applied and scholarly literature were also applied to confirm the sample set, detailed also in our previously study.

Accordingly, the study was not a study of the multi-faceted politics that influence dental care systems and their development, and the roles of professional and consumer groups in policy advocacy. Rather, it was a study of the translation of scholarly oral health research into national oral health policy statements as it relates to health inequalities.

ANALYTIC PROCEDURE

Overview

The analytic procedure had two stages that involved 1) mapping concepts in the research abstracts and then the policy documents, and 2) manual comparison of these two sets of concepts. These analyses were performed using the concept mapping software Leximancer (Leximancer version 4). In Leximancer the unit of analysis is a 'text block' about the length of a paragraph. The software is able to learn from a corpus of uploaded texts in an iterative fashion. It creates a spatial representation of concepts as a network of interconnected entities—a concept map.

The technical aspects of the Bayesian-based Leximancer software have been explored in validity studies[21] and in hundreds of applications[22-29] The algorithm-based nature of Leximancer draws on the discipline of computational linguistics. Leximancer has been defined as an automated approach to transforming co-occurrence information about words into semantic patterns. The algorithms used in Leximancer involve machine learning as summarised in the technical validity study:

> A unified body of text is examined to select a ranked list of important lexical terms on the basis of word frequency and co-occurrence usage. These terms then seed a bootstrapping thesaurus builder, which learns a set of classifiers from the text by iteratively extending the seed word definitions. The resulting weighted term classifiers are then referred to as concepts. Next, the text is classified using these concepts at a high resolution, which is normally every three sentences. This produces a concept index for the text and a concept co-occurrence matrix. By calculating the relative co-occurrence frequencies of the concepts, an asymmetric co-occurrence matrix is obtained. This matrix is used to produce a two-dimensional concept map via a novel emergent clustering algorithm. The connectedness of each concept in this semantic network is employed to generate a third hierarchical dimension, which displays the more general parent concepts at the higher levels. [21]

However, the usefulness of the software lies not simply in its concept map and supporting quantitative data allowing scoping of a large body of qualitative data. Leximancer also facilitates manual checks of large qualitative datasets. It provides multiple data viewing windows that allow the analyst to scrutinise the text on which the data are based, in the context of the original uploaded text. This allowed this study to include extensive manual checking procedures in its research design, to extend the machine-driven findings.

Stage 1. Machine-automated mapping of the content of abstracts and policy documents

In the first stage of this study, the automated Leximancer procedures were used to ensure that the two different samples—the research abstracts and the policy documents—were subjected to the same research procedure for their analysis. That is, the research abstracts were uploaded in Leximancer to produce a concept map and, as an entirely separate procedure, the policy documents were uploaded in Leximancer to produce a second concept map. Concepts were therefore selected by the software with only one kind of intervention by the analyst. Meaningless concepts such as structural features of abstracts ('aims' or 'conclusions') were removed as mapping concepts as were names of countries i.e. this content was not excised but rather subsumed by Leximancer under other mapping concepts. This intervention was designed to ensure that the data output produced by Leximancer represented the conceptual content of the two different corpuses. This analysis produced concept maps showing not only the semantic placement of one concept relative to all other concepts, but also the typical pathways or connections across multiple concepts i.e. the typical storylines characterising the data.

This study therefore analysed two concept maps both with supporting data: a concept map with 55 concepts for the abstracts and a concept map with 33 concepts for the policy documents. In the abstracts, 1,604,212 instances of the mapped concepts were found by Leximancer in 1,197,367 distinct text blocks. In the policy documents, 14,612 instances of the mapped concepts were found in 3,482 distinct text blocks. Instances are challenging to conceptualise in terms of quantity. Other concepts are more assumable, such as the notion of the content of a book. For this study, the included abstracts equated to almost 1,596 books of about 250 pages each, assuming three text blocks per page. For the corpus of policy documents, using the same assumptions, this equates to 4.6 books. The use of two different sets of data analyses, one for each dataset, means that differences in the size of the datasets are not an issue.

Stage 2. Manual checks and comparison of concepts

In the second stage of the study, manual checks aimed to document substantive conceptual differences further, as well as similarities between the research abstracts and the policy documents, particularly as they relate to health inequity. These checks were undertaken in two steps as follows,

- *Step 2.1.* A set of categories to support the manual comparisons was developed by scrutinising all concept words—the tag word used to describe a concept by Leximancer, as identified in Stage 1. Four possible categories for the concept words were decided: 1) matching concept words (in whole or part of case) that might have the same apparent meaning; 2) different concept words that might have the same or very similar meaning; 3) matching concept words (in whole or part of case) that might have a different substantive meaning; and 4) concept words that did not match and were most unlikely to have the same or similar meaning. All concepts from both the Stage 1 analysis of the abstracts and the policy documents were then provisionally placed in these four categories.
- *Step 2.2.* The qualitative data relevant to the first three categories of concept words were scanned in both the abstracts and the policy documents using Leximancer's data viewing windows. A specific kind of data viewing window was used for this purpose that extracts the sentence in which the concept appears, greatly expediting the scan. The larger context of the sentence was extracted only when the meaning of the concept word in the sentence was not obvious. This exercise focussed only on obvious, not subtle, differences in meaning, for instance, the difference between the word 'system' used to refer to biological systems in the abstracts and healthcare systems in the policy documents. It also focussed on identifying whether the concept sentences belonged in the category at least two-thirds (>66%) of the time or not.

Therefore, in this step it was not necessary to read the entire corpus of oral health abstracts as few of the concepts in the abstracts actually matched or were even possibly related to the policy concepts i.e. only concepts initially categorised in Step 2.1 as being in categories 1-3. In the abstracts, a total of 488,525 sentences or instances of 10 concepts (highlighted in Table 2) were scanned. In the policy documents, a total of 5,372 sentences or instances of 10 concepts (also highlighted in Table 2) were scanned. This equates to 39 books scanned for the abstracts, assuming 50 sentences a page and 250 pages a book. For the policy documents and again using the same assumptions, it equates to 107.4 pages manually scanned.

Results

MACHINE-AUTOMATED CONTENT MAPPING

Figure 1 offers a concept map of the 127,193 research abstracts i.e. the 1,604,212 instances of 55 concepts found by the software. The concept map is a spatial representation of the frequency and overall co-occurrence of all 55 concepts. As such, it offers multiple dimensions in a 'snapshot'—the detailed list of concepts, including those obscured in the map because they fall too close together, is discussed in the next section. In the original figure—of which Figure 1 is a black and white reproduction—the colours of the spheres are shaded from the most frequent or warmest colour (red) to the least frequent or coldest colour (purple)—as in the traditional colour wheel. The placement of concepts is, however, determined by their overall co-occurrences—for an individual concept, its relationships with all other concepts. The pale grey lines suggest typical storylines linking multiple concepts. The grey dots are larger depending on the extent to which a concept co-occurs with all the other concepts.

Accordingly, Figure 1 indicates that healthcare system and workforce development concepts in the purple sphere, such as 'care', 'education' and 'community', are less frequent and more often found together in the abstracts. These concepts are poorly connected and tend not to form typical storylines, as suggested by the lack of grey lines connecting them to one another or to other concepts. This indicates that, even when healthcare system and workforce development concepts appear in this literature, they are not part of well-developed theoretical constructs that allow connections to be developed between them and clinical evidence. In contrast, clinical concepts dominate the content of abstracts, predominantly laboratory-based and clinical evidence concepts. Figure 1 also indicates that clinical concepts are much better connected in typical storylines across multiple clinical concepts. The figure suggests a visually striking degree of disconnection between clinical concepts and healthcare system and workforce development concepts. Yet, the abstracts for the most recent years (2010-2012) are closest to the healthcare system and workforce development concepts, suggesting oral health research is including more of this kind of content in more recent years.

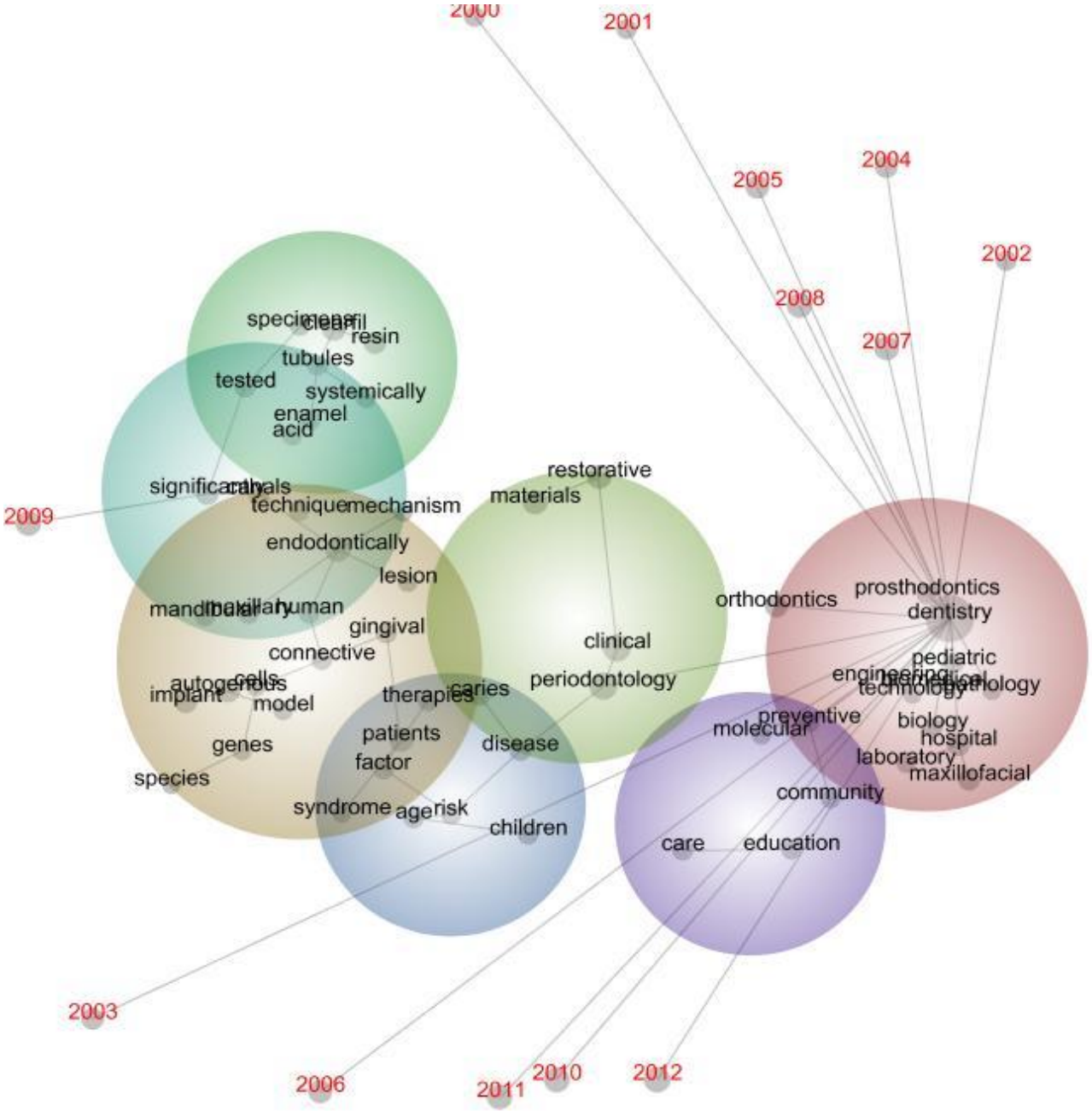

Figure 1. *Concept map of oral health abstracts, by year*

Figure 2 provides the concept map for the oral health policy documents, produced using the same procedure, using the automated Leximancer concept mapping procedure with minimal analyst intervention. When compared with the concept map of oral health abstracts in Figure 1, Figure 2 suggests how much more the concept of health, not clinical dentistry concepts, lies at the centre of the way policy understands oral health. The more common concepts in the sphere in Figure 2 are concepts about services, care, needs, access, community and training—not clinical concepts. Where the concept of dentist occurs (in the red sphere) in Figure 2, it is proximate to the concept of training. Similarly, where the concept of dental occurs (in the pale brown sphere) in Figure 2, it is typically connected with the system concept.

When comparing Figures 1 and 2, it appears as if oral health research preoccupations are the opposite of policy preoccupations. Figure 1 demonstrated that clinical and disease

concepts are the best connected and most frequent concepts (as the supporting data suggest), with the opposite being true of the healthcare system and workforce development concepts. In striking contrast, in Figure 2 mapping the policy documents, specific disease concepts such as cancer and research and data concepts tend to be less common (as the supporting data also suggest) and least well connected to the workforce and healthcare system concepts. Disease, as a general concept, is in fact proximate to the social concept in the policy documents. These figures raise the question of whether similar concepts in the two figures mean different things or whether apparently different concepts mean the same thing. In other words, is the content of oral health research even more different, or more similar, than these figures suggest? Manual checks comparing the substantive meaning of the different concepts allowed exploration of the answers to this question.

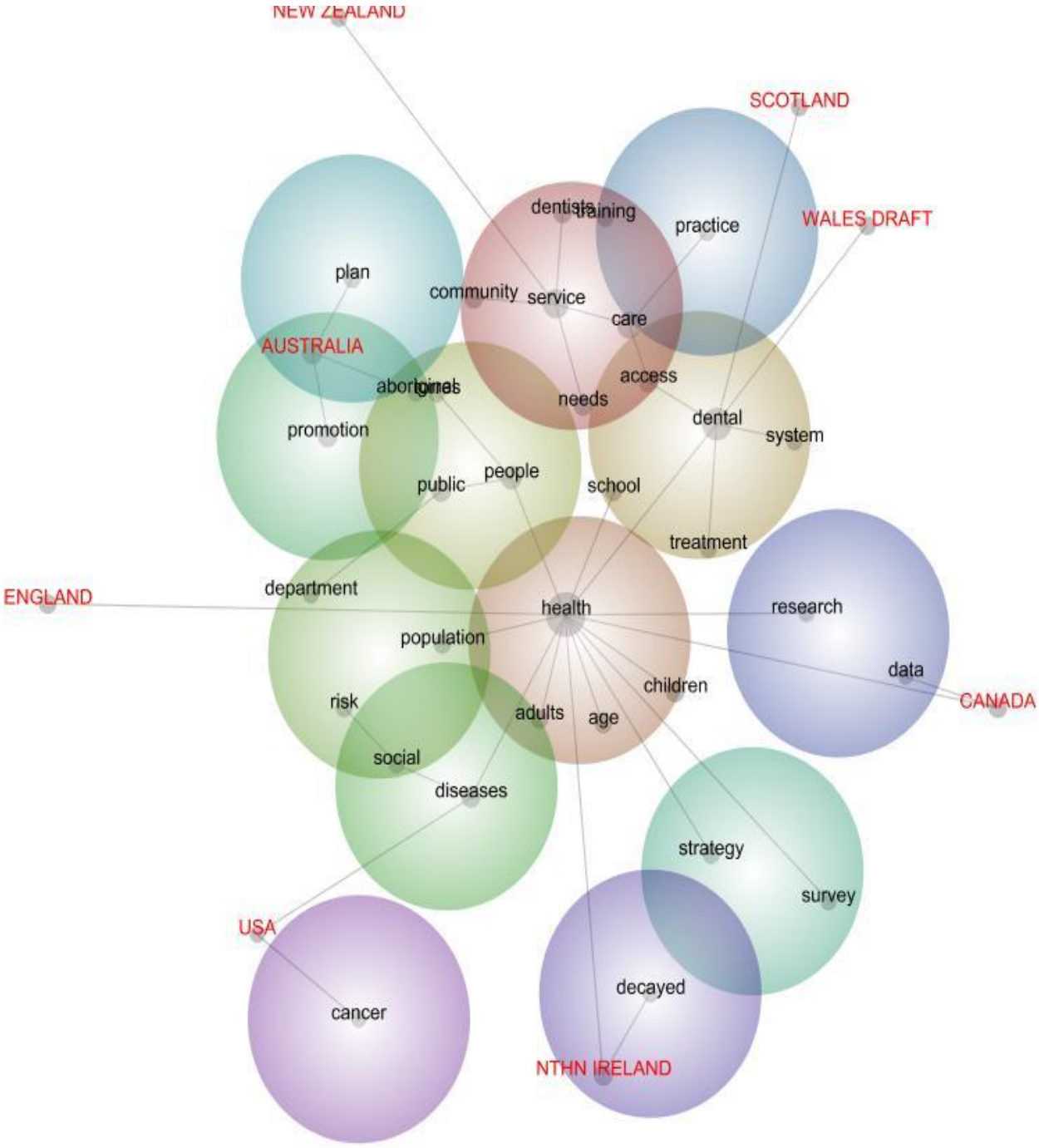

Figure 2. *Concept map of oral health policy documents, by country*

MANUAL CHECKS AND COMPARISON OF CONCEPTS

Table 2 (Appendix A) provides a list of the 55 concepts in the 127,193 oral health abstracts versus the 33 concepts found by Leximancer in the eight oral health policy documents. Counts and likelihood of occurrence of concepts in the two different corpuses are included. Table 2 demonstrates that only eight out of the 55 research concepts are policy-relevant in the sense that they mean the same as concepts used in policy language. However, only two of these concepts are in the top 12 most common research concepts whereas seven of these concepts are in the top 12 policy concepts. Only six of these eight concepts involve using the same concept word to mean the same thing. The concept of community is one of the least important research concepts with a likelihood of occurring 3% of the time in any one of the 1,197,367 distinct text blocks in the corpus of abstracts. However, the concept of community is almost four times more likely to appear in the policy documents with an occurrence likelihood of 11%. Most concepts relevant to healthcare system and workforce development in the policy concepts have no equivalent concept in the research concepts.

Discussion

This study findings indicate that, far from being 'lost in translation', oral health research and policy are so different as to raise doubts about the extent to which research is policy-relevant or policy is evidence-based, most of the time. Most of the evidence is not policy-relevant and most of the time, policy is not drawing on the evidence.

In this study, the key directions for oral health research suggested by leading policy concepts lie in developing a health-based concept of oral health, informed by services and workforce development research that would allow better design of oral healthcare delivery. In so doing, this study indicates that the nature of the evidence-policy divide for addressing oral health inequality is not simply about evidence translation. It is also about the nature and sufficiency of particular kinds of evidence in oral health. Research cultures are sometimes arguably more focussed on generalizable measures of significance to do with disease and risk factors rather than local healthcare systems and communities. Therefore, it is possible that differences between research and policy would have most likely been even larger if provincial or state policy documents were the focus of the study. The present research reflects the fact that the specialty area of dental public health, which is more likely to focus on policy-relevant concepts such as access, systems delivery, and community perspectives, is a small and sometimes marginalised area within dentistry. Therefore, the study is potentially useful to those who wish to call for a greater emphasis on dental public health, including professional and consumer associations acting as policy advocates.

The debate about the policy relevance of research is ultimately about values. No claim is made here that there should be a perfect alignment of research and national oral health policy. Rather, the study raises the question of whether the divide should be as large as the indicative evidence here suggests. It is hoped that this study will contribute to deeper discussion in oral health about the extent to which research is serving the development of sound national policy—one way in which research can contribute to solutions for disadvantaged groups. If the results of the knowledge production system are not empirically measured—to demonstrate the extent to which policy and research are aligned—it is difficult for those who want to question such knowledge production systems to have any basis for doing so.

The notion of 'policy persuasive research' may help frame these findings. It would appear from the results of this study that high quality research does not influence policy. While professional bodies may advocate for evidence-based research to be used in policy, this study suggests that little of this research actually becomes policy. The broader policy literature suggests many explanations for the policy-evidence disconnect in health—what is lacking is empirical measurement of the divide, particularly in oral health. It is known that the evidence-policy divide in health has a complex causality[30]: policy-making is aligned to political, financial and strategic imperatives[31,32]; evidence does not always capture different stakeholder needs[33]; many 'real world' local contextual limitations unaccounted-for by researchers apply to policy-making[34]. Analysis of the literature explores debates about how quantitatively defined disciplines such as oral health too often fail to capture the complex contexts of policy while qualitative research is perceived as lacking the defensible rigor required for the adversarial and warring interests found in policy contexts[2,35].

POLICY OPTIONS

The disconnect between policy and research needs to be addressed.

- Researchers and policy advisers need to understand the disconnect between their two world views,
    - Develop a course for researchers to understand the policy adviser world view
    - Develop a course for policy advisers to understand the researcher world view

    - Both courses should be organised by someone with experience in both policy making and as a researcher in the university sector.

- As research evidence takes a lot longer to accumulate, the best way for policy advisers to obtain evidence for policy is to ask eminent researchers in the appropriate field to give an overview of a topic prior to policy being formulated.
    - A clear set of guide lines or a template would be required for the report to policy advisers that includes the length (preferably short), and encouragement of the use of dot points in any recommendations, research outcomes and limitations of the research.
    - A short time-line (two weeks) would need to be set for the report to be submitted.
    - The report should have a dot point executive summary of no more than one page in length.
- Government should encourage research which answers current policy questions.
    - Researchers should be able to apply for policy research grants in their fields.
    - Also, policy advisers should phrase policy questions which have not been solved and are relevant in the current political context, and then open grant applications for researchers to answer the policy question.

Conclusions

There is a striking degree of disconnection between clinical concepts and health care system and workforce development concepts. Oral health research and policy are so different as to raise doubts about the extent to which research is policy-relevant and policy is evidence-based. The notion of policy relevance encompasses the lack of willingness of policy advisers to embrace research, and the need for researchers to develop research that is, and is seen to be, policy-relevant.

This study has suggested that evidence-based abstracts, and national oral health policies, are two conversations happening in parallel. It provided some support for those wanting to make the two conversations better merge and result in changes to oral health policy. Some public oral health debates have managed to achieve this single conversation, such as the water fluoridation debate. Oral health researchers might see in this study impetus to learn from the fluoridation example to develop strategies to make their research more policy-persuasive.

This study has also suggested that machine and algorithm-based approaches can help measure language phenomena where anecdote and opinion about research translation have not worked so well to create a basis for change. *The Lancet* has published an influential suite of papers on research waste arguing that 85% of medical research investment is wasted[36] however these focused on research translation into practice, not policy[36].

LIMITATIONS OF THE STUDY

The major limitation of the study is that Leximancer treats all research and policy terms as equal when some may be of more importance than others. No value judgements are made.

However, the volume of research studies suggests that this study will give an indication of what researchers decided to spend their time researching, and hence, what they considered to be important. This study will contribute to informed debate about what kinds of methods can help evaluate the value to the community of its investment in research, particularly for the most vulnerable and disadvantaged, and especially in fields such as oral health where the problem of research translation has been so little treated.

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Appendix A: Table 2

Research abstracts			Policy documents		
Concept	**Count**	**Likelihood**	**Concept**	**Count**	**Likelihood**
dentistry	334,265	100%	health	3,274	100%
clinical	77,648	23%	dental	1,487	45%
periodontology	71,317	21%	service	1,054	32%
endodontically	54,375	16%	care	816	25%
restorative	49,106	15%	people	615	19%
patients	48,045	14%	promotion	522	16%
materials	47,028	14%	public	465	14%
significantly	46,474	14%	diseases	463	14%
autogenous	44,489	13%	access	407	12%
orthodontics	41,103	12%	children	404	12%
implant	39,318	12%	community	388	12%
hospital	37,194	11%	needs	362	11%
canals	31,952	10%	plan	319	10%
clearfil	30,469	9%	dentists	316	10%
maxillofacial	30,125	9%	population	312	10%
care	29,261	9%	strategy	293	9%
disease	26,631	8%	age	267	8%
cells	25,714	8%	adults	257	8%
tested	24,795	7%	risk	244	7%
resin	24,312	7%	practice	239	7%
prosthodontics	23,804	7%	treatment	225	7%
caries	23,660	7%	school	221	7%
age	21,813	7%	social	220	7%
children	21,649	6%	training	206	6%
connective	21,550	6%	research	182	6%
tubules	20,222	6%	system	166	5%
maxillary	20,166	6%	survey	163	5%
enamel	20,135	6%	decayed	161	5%
education	19,861	6%	department	160	5%
factor	19,821	6%	cancer	109	3%
gingival	18,945	6%	Torres Strait Islander	103	3%
mandibular	18,687	6%	Aboriginal	102	3%
human	16,966	5%	data	90	3%
risk	16,784	5%	**TOTAL INSTANCES**	14,612	
preventive	15,854	5%			
specimens	14,532	4%			
model	14,318	4%			
lesion	12,714	4%			
biology	12,336	4%			
engineering	12,288	4%			
technique	12,125	4%			
systemically	11,158	3%			
community	11,110	3%			
pediatric	10,835	3%			
acid	9,679	3%			
therapies	9,360	3%			
molecular	7,971	2%			

pathology	7,813	2%
biomedical	7,356	2%
species	6,903	2%
laboratory	6,693	2%
genes	6,625	2%
technology	6,457	2%
syndrome	5,240	2%
mechanism	5,161	2%
TOTAL INSTANCES	1,604,212	

Table 2: Counts of instances of concepts in text blocks in oral health abstracts versus oral health policy documents (yellow= concept words match (in whole or part of case) and have the same or similar meaning >66% of the time; grey=concept words are different but the meaning is the same or very similar >66% of the time; aqua=concept words match (in whole or part of case) but substantive meaning is different >66% of the time; plain text=concept words do not match and are most unlikely to have the same or similar meaning)