

Christchurch Earthquake 22 February and Its Impact on PHO Enrolment in the Canterbury DHB

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Abstract

This article describes the changes in patients enrolled with Primary Healthcare Organisations (PHOs) in Canterbury District Health Board (CDHB) over eight quarters starting July 2010 and ending June 2011, including one quarter after the devastating earthquake 22 February 2011. The main findings are as follow:

- The enrolment in CDHB dropped by about 1% after the earthquake*
- There was a small reduction in patients who joined CDHB, and a significant increase in the number of patients who left CDHB after the earthquake*
- There are 80 practices located in the Canterbury region where quarterly patients inflow or outflow exceeded average values by two standard deviations.*

These findings show that the earthquake caused patient movement that was higher than average in the two years prior to the earthquake.

1. Introduction

The devastating earthquake that shocked Christchurch 22 February 2011 generated an increased interest in its impact on the New Zealand economy and healthcare system.

Shortly after the earthquake the media announced that “Auckland's population is expected to swell by up to 21,000 as exhausted Christchurch residents flee damaged homes and aftershocks. Christchurch Mayor Bob Parker has estimated that up to 70,000 people - about one-fifth of his city's pre-quake population - have left. It is believed that one-third of evacuees will end up in Auckland” [1].

Canterbury District Health Board (CDHB) commissioned the Sapere research group (former LECG) to assess the impact of the population movement after the earthquake in planning for the provision of future health services [2]. The literature review conducted by Sapere [3] included analysis of the impact of hurricane Andrew, the Kobe earthquake and hurricane Katrina on the movement of the affected population. The study shows the different impact of the natural disasters on population movement. There are many factors which should be taken into account when projecting the possible impact, including socio-economical position of the affected region, severity of the disaster etc.

Analysis of the school children re-enrolment data after the Christchurch earthquake [3] concluded that it is likely that the Christchurch population may change by 1 to 2 percent either up or down, but it is highly unlikely that it will ever reach the level of 70,000 people reported by media.

Whilst in the short term school children reenrolment data was a good proxy to assess population movement after a natural disaster, use of patient enrolment with primary health care providers may be a more accurate way to monitor population movement.

Natural disasters can significantly change a population's socio-demographic profile, due to migration in and out of the affected area. The series of earthquakes that shook Christchurch from September 2010 until now are likely to impact on the primary care enrolment and government subsidies paid to practices operating in Canterbury DHB. It is therefore important to consider these population changes in any future enrolment and funding forecasts.

With the introduction of the primary health care strategy in 2001 and its implementing in the New Zealand, the health sector was given a great opportunity to collect primary care patient information on a regular basis, starting from October 2002. By 2005 the primary care database had collected information on the location and socio-demographic profile of over 90% of all New Zealanders.

PHOs supply the Ministry of Health with primary care patients information for the purpose of distribution of capitation-based funding between Primary Health Care service providers on a quarterly basis. The snapshot of the register happens on the 20th of the second month prior to the start of each quarter. For instance the data extraction for first quarter of the register occurs on the 20th November of the previous year. This data was used to track enrolees' movement between every two subsequent quarters.

2. Canterbury DHB enrolment history

The Ministry of Health (MoH) has responsibility for national collections of health and disability information. One of the datasets the MoH maintains is the Primary Health Organisation (PHO) Enrolment Collection [4]. The collection contains a quarterly extract of all patients enrolled with PHOs with unique identification, practice and enrolment start date information. These three variables make it possible to track primary care enrolee movement from one practice to another one in between two consecutive quarters. The tracking methodology is known by health economists as a "Stock and Flows Model".

All practices listed in the national PHO database starting from 1 January 2007 were linked to their street address and geocoded to make it possible to separate Christchurch practices from non-Christchurch practices within CDHB.

The CDHB enrolment profile has been extracted from the primary care enrolment data to identify a background trend in the quarterly enrolment and an effect of the earthquake on the enrolment in the quarter started 1 July 2011. PHO enrolment registers submitted every quarter starting from 1 January 2007 and ending 1 July 2011 were used for this analysis. The total number of enrolees over nineteen quarters is presented on the Figure 1.

The graph shows the steady growth of the enrolled population over 2007-2008, with a slightly lower increment in growth over 2009-2010, and finally a reduction in the last quarter enrolment. This reduction in the PHO enrolment is likely to have been caused by the February 2011 earthquake. The average quarterly growth rate over the last four years was 0.52%, but the Canterbury enrolled population dropped by 1.06% (or 5,227 enrolees) between Feb-2011 and Apr-2011.

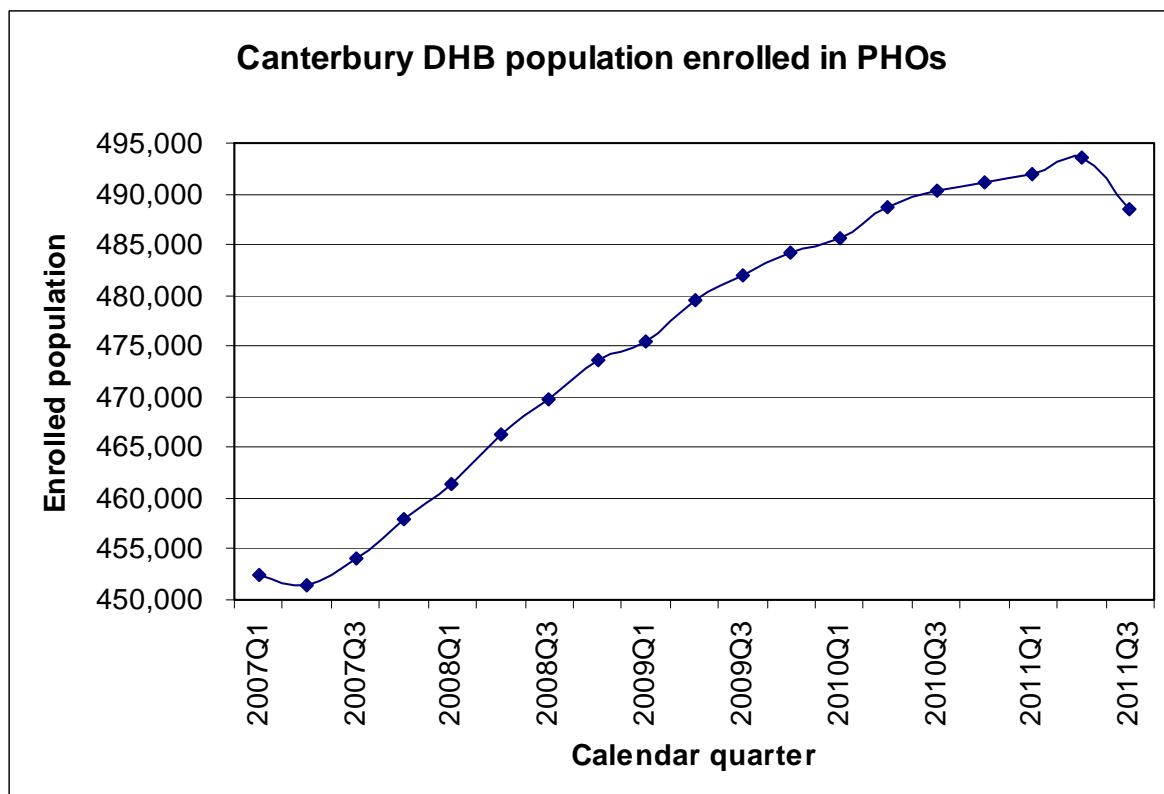


Figure 1 – Trend in the population enrolled with PHOs in CDHB

3. Canterbury DHB practices in the stock and flows model

Stock Flow analysis is defined as an “analysis of the behaviour of individuals or markets at a fixed point in time, and over periods of time” [5]. This technique is increasingly used in different areas of health economics [6, 7] and is used in this study to perform the detailed analysis of PHO enrolment at the practice and patient levels over two years (eight quarters starting from July 2009 and ending in June 2011).

The time frame of eight quarters that we looked at covers patient movements in and out of CDHB prior to earthquake and after the earthquake and it is likely to capture general trends in patients’ movements and to filter out the earthquake related component of these movements.

There were 134 practices operating in CDHB in July 2009 and 130 practices operating in June 2011. The analysis covered every individual patient enrolled in every individual practice operating in the CDHB over last eight quarters. All enrolled patients in the each of those practices in each quarter comprise the current **stock** of enrolled patients. In general, the stock flow model has three main components which are:

- The stock of enrolled patients in quarter (q), $Stock_q$
- Inflows to the stock in quarter (q), $Inflow_q$
- Outflows from the stock in quarter (q), $Outflow_q$

These measures are linked to make up the following equation:

$$Stock_{q+1} = Stock_q + Inflow_{q+1} - Outflow_q$$

For every quarter the enrolled population in each practice was split into the following five categories:

1. Stayers – enrollees who stayed in the same practice in two subsequent quarters.
2. Internal inflow – patients who changed practice in two subsequent quarters.
3. Internal outflow – patients who changed practice in two subsequent quarters.
4. External inflow – patients who came from outside of DHB, newborn and new residents.
5. External outflow – patients who left DHB practices or un-enrolled.

$$Stayers_{q,q+1} = Stock_{q+1} - Outflow_q$$

The internal inflow and internal outflow show the patients’ re-enrolment within the same DHB and the outflow from one practice is the inflow into one of the other practices in the CDHB. The totals for internal inflow and outflow are equal while the individual practices might have significant variations.

It should be noted that some internal flows might be caused by practices’ amalgamation or any other restructures.

External flows determine the value into the net of quarterly enrolment and have to be analysed in more detail. External inflows show where people are coming from while external outflows show where people have gone. These flows are shown in the Table 1.

The table presents external flows in and out of CDHB in 2010Q3 (July 2010) and 2011Q3 (July 2011) with the aim to pick up the impact of the earthquake. It shows a 16% reduction in the external inflows (new patient enrolment from outside of Canterbury) and a 68% increase in the external outflow after the earthquake. Unknown DHB inflows indicate patients who registered with PHOs in CDHB in 2010Q3 or 2011Q3, but were not enrolled with any PHO in New Zealand in the previous quarter (2010Q2 or 2011Q2). Similarly, unknown DHB outflows indicate patients who enrolled with PHOs in CDHB in 2010Q2 or 2011Q2, but were not enrolled anywhere in New Zealand in 2010Q3 or 2011Q3, respectively. The detailed variations in the external flows over last eight quarters are presented on Figure 2.

The graph in Figure 2 shows that in all quarters prior to the earthquake the number of external patients enrolled with PHOs in CDHB (external inflow) was always higher than external outflows. External inflows have not changed significantly after the earthquake. However, a significant increase in the external outflows and internal flows can be observed.

The changes in the internal and external flows presented in Table 1 and Figure 2 clearly show the change in patient flows after the earthquake compared to the average level over latest eight quarters.

Table 1 – Canterbury DHB Patient’s External Flows

DHB	2010 In-flow from	2010 Out-flow to	2010 Net-flow	2011 In-flow from	2011 Out-flow to	2011 Net-flow
Unknown DHB	7300	5179	2121	5977	6205	-228
Auckland DHB	175	276	-101	287	1097	-810
Bay of Plenty DHB	85	116	-31	92	242	-150
Capital Coast DHB	226	329	-103	212	538	-326
Counties Manukau DHB	183	154	29	46	711	-665
Hawkes Bay DHB	85	65	20	75	193	-118
Hutt DHB	63	76	-13	53	157	-104
Lakes DHB	60	44	16	41	150	-109
Mid Central DHB	109	110	-1	87	265	-178
Nelson Marlborough DHB	396	359	37	355	1049	-694
Northland DHB	97	89	8	57	206	-149
Otago DHB	608	573	35	609	1257	-648
South Canterbury DHB	273	197	76	256	507	-251
Tairāwhiti DHB	29	23	6	14	39	-25
Taranaki DHB	46	59	-13	52	90	-38
Waikato DHB	184	178	6	153	424	-271
Wairarapa DHB	32	26	6	29	49	-20
Waitemata DHB	125	138	-13	86	202	-116
West Coast DHB	205	187	18	188	321	-133
Whanganui DHB	38	28	10	40	61	-21
Total:	10319	8206	2113	8709	13763	-5054

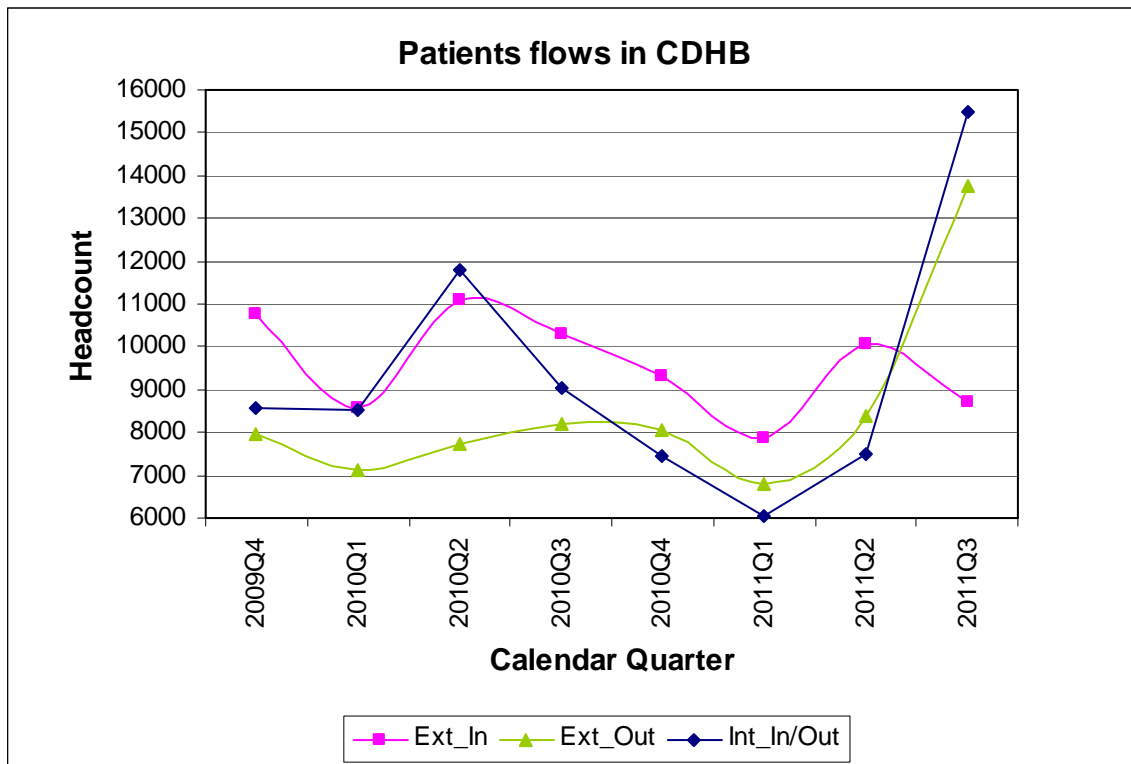


Figure 2 – Patients Flows in CDHB

Table 2 - Summary of Key Formatting Rules

Earthquake Impact	Internal Inflow	Internal Outflow	External Inflow	External Outflow
Low	68	48	14	98
Medium	27	19	2	62
High	0	0	0	0

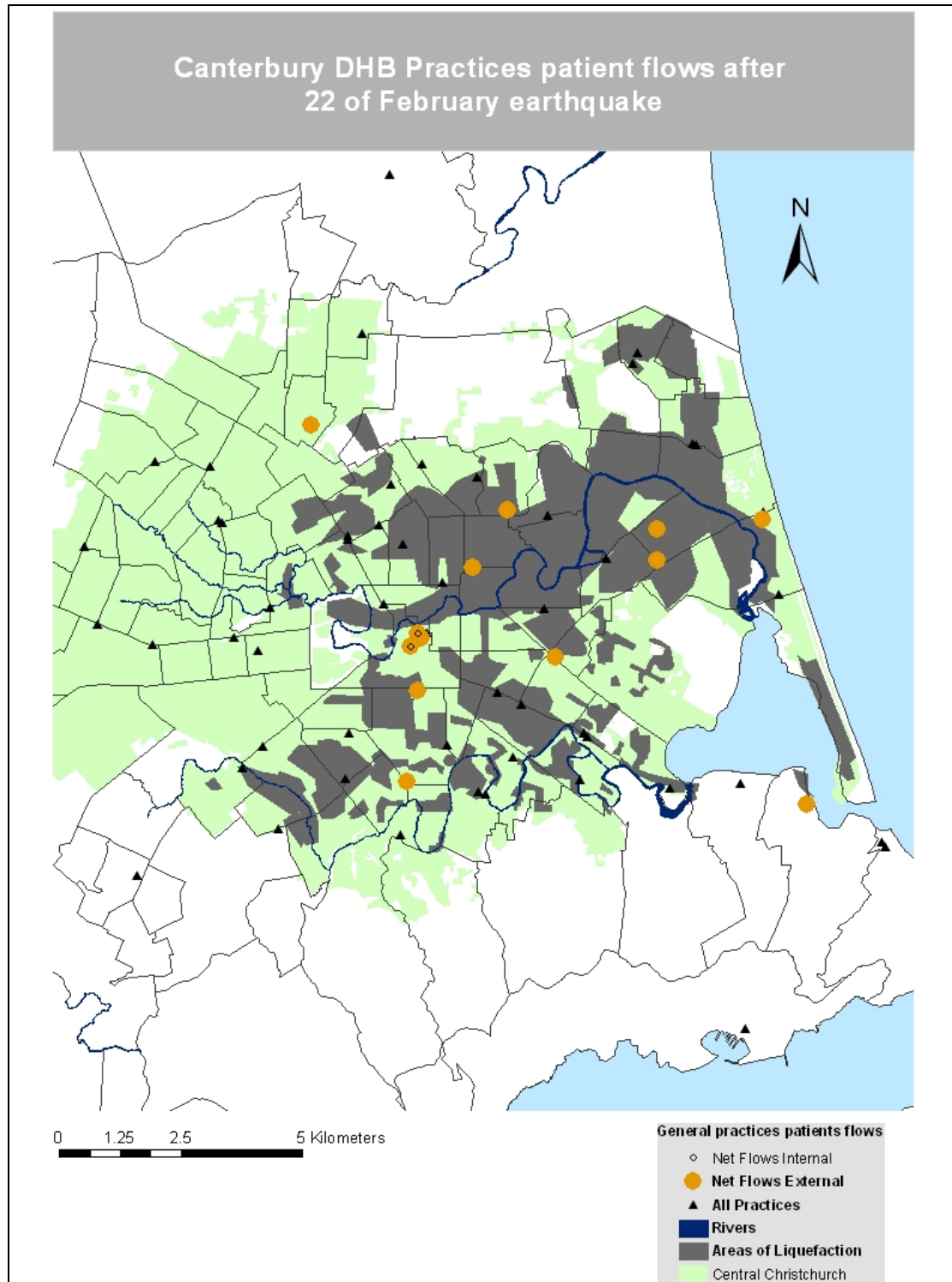


Figure 3 – Christchurch practices spatial distribution

It was expected that there would be a big-bang type of impact on enrolment flows as a result of the earthquake and as such the flows in the last quarter would significantly exceed average quarterly flows in the Canterbury DHB.

General Practices were then defined by three levels of earthquake impact, as follows:

1. Low impact – where patient flow in the last quarter was less than average plus standard deviation in the last eight quarters.
2. Medium impact – where patient flow in the last quarter was less than average plus two standard deviations in the last eight quarters.
3. High impact – where patient flow in the last quarter was less than average plus three standard deviations in the last eight quarters.

The numbers of practices analysed and the level of impact the earthquake had on them are presented in Table 2.

There were 122 practices that exceeded the low level impact and 80 practices that exceeded medium level impact and no practices with high impact in their flows in the last quarter. If there is an earthquake component in the patients' flows it is more likely to be captured in practices with medium patient flows. For this purpose all practices with medium level of patient flow in the latest quarter were analysed spatially using Arc GIS 10. This map is presented in Figure 3.

The map shows practices that have the most external outflow of patients. All practices are shown as triangles. Filled circles represent practices with high external flows. There are two practices shown as Black hollow circles showing significant internal outflow. A nearest neighbour analysis was conducted in ArcView that showed practices with high external outflow are not significantly clustered together in any way. Even so, when the map is overlaid with the areas which have the most liquefaction (to the East of central Christchurch), these are where practices with the highest external flows are located.

This means that patients living in the most earthquake damaged areas have been moving out of Christchurch, (either temporarily or permanently) rather than finding homes elsewhere within the city. There has been little significant movement out of Christchurch elsewhere in the city where there was not significant damage.

4. Conclusions

This analysis was based on the comparison of one quarter of the enrolment register from after the earthquake with seven quarters of the register from before the earthquake. It has picked up changes in the patient enrolment which are likely caused by the earthquake. The enrolment of external patients into practices operated in CDHB stayed inside the average quarterly variation, but the external outflow of patients from CDHB increased significantly after the earthquake, contributing to the reduction of the enrolled population by 1%.

There were 80 practices out of 130 which had a medium level of impact on their enrolment. However, it is likely that some enrollees moved to other places, but have not visited GPs or completed enrolment forms with new practices and were not captured as flows. The next two quarters will show much more accurately the impact of the Christchurch earthquake on primary care patient enrolment in the Canterbury DHB.

5. References

- [1] New Zealand Herald http://www.nzherald.co.nz/population/news/article.cfm?c_id=608&objectid=10710235
- [2] http://www.cdhb.govt.nz/communications/documents/pdf/letter_population_movement.pdf
- [3] Population movement after natural disasters: a literature review and assessment of Christchurch data, Available at <http://www.srgexpert.com/Population%20movement%20after%20natural%20disasters%20-%20a%20literature%20review%20and%20assessment%20of%20Christchurch%20data.pdf>
- [4] Primary Health Organisation (PHO) Enrolment Collection, Available at <http://www.moh.govt.nz/moh.nsf/indexmh/dataandstatistics-collections-pho>
- [5] Bunshaw DW, Glower RW. Introduction to Mathematical Economics (Homewood, III.), 1957
- [6] Birch S., Kephart G., Tomblin-Murphy G., O'Brien-Pallas L., Alder R., and MacKenzie A. "Human Resources Planning and the Production of Health: A Needs-Based Analytical Framework," Canadian Public Policy, XXXIII, Supplement. 2007.
- [7] N. Minko, M. Rains, "Workforce forecasting model", HINZ conference, 2008, Available at <http://www.hinz.org.nz/uploads/file/2008conference/p14.pdf>