

Discovering Health Knowledge in the BC Nurse Practitioners Encounter Codes

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Abstract. Integrating the Nurse Practitioner (NP) role into clinical practice settings is new in British Columbia (BC), Canada. Encounter codes are unique numeric codes assigned to specific types of patient care services performed by NPs. In this study we apply knowledge discovery techniques to analyze the encounter codes extracted from the BC Ministry of Health database to understand the most common practice activities carried out by NPs and what diseases patients sought care for from NPs. The analysis produced important information about NPs' practice patterns. This work leads to a better understanding of NP practice patterns in BC.

Keywords. Nurse Practitioner, Data Mining, Knowledge Discovery, Health Care

Introduction

A Nurse Practitioner (NP) is a registered nurse who has additional education and training in a specialty area such as family practice. The NP role has existed in many Canadian provinces and the United States for more than 40 years [1]. In Canada, NPs are part of the front-line team providing primary health care to Canadian citizens. The evidence accumulated over these years has consistently demonstrated that NPs provide safe and effective care. Researchers consistently find that patients are satisfied with the care received from NPs, trust NPs, feel that NPs take their problems seriously and discuss their concerns, have expert communication skills, and are approachable [2-4].

Since 2005, when legislation enabling the NP role was enacted in British Columbia, (BC) integrating the role into clinical practice settings has been a priority. To date, \$62.6 million has been invested to support and resource the integration of NPs. At the same time, the BC Ministry of Health (MoH) developed encounter codes (ECs) to be used by NPs to track their practice activities. ECs are unique numbers assigned to specific types of patient care services performed by NPs. NPs are expected to submit an encounter code to the MoH at the end of each patient encounter.

The main objective of this paper is to answer the following two questions. 1) What are the most common practice activities carried out by NPs during encounters with patients? 2) What are the most common health conditions for which patients sought care for from NPs? To answer these questions we applied the knowledge discovery process proposed by Sangster-Gormley et al. [5] to extract useful NP practice information from the BC MoH database. The study results will provide the MoH with a better understanding of NP practice patterns.

1. Methods

The data set released by BC MoH was integrated based on practice records sent by 94 NPs in BC from the 2005-2010 fiscal years [6]. There are 470,762 records in the database. Since NPs started their practice late in 2005, the data only covered 4 months (January 1 to April 30, 2006) for this fiscal year and only 4 NPs submitted 2,214 ECs in the 2005 fiscal year. As a result, the amount of data for this year was small compared to other years. Thus, in this study, we excluded data from 2005. All the data we used were related only to NPs' practice. Among the variables in the database, ECs (called "Fee item" in the database) reflected NP practice activities and International Classification of Diseases 9 codes (ICD-9) indicated patients' diagnoses.

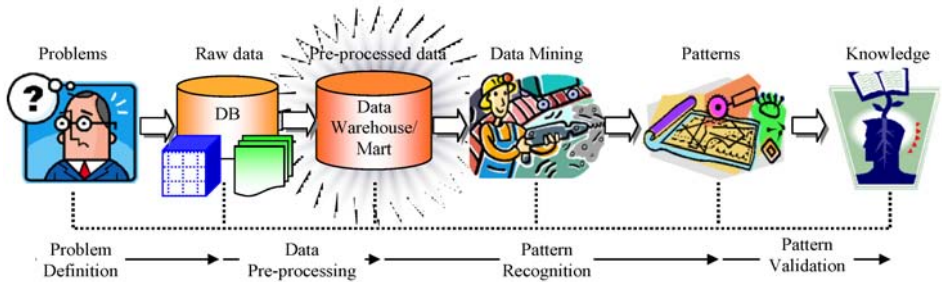


Figure 1. The NP practice knowledge discovery process

The NP practice knowledge discovery is a processing pipeline that involves 4 distinct stages including problem definition, data pre-processing phase, pattern recognition and pattern validation (see Figure 1).

Stage 1- Problem Definition

In this stage we are attempting to answer the following two questions: What are the most common practice activities carried out by NPs? What are the most common health conditions for which patients sought care for from NPs?

Stage 2- Data Pre-processing

In this stage raw data is transformed into an appropriate format for subsequent analysis. Among the variables in the database, ECs and ICD-9 codes reflected NP practice activities and displayed the types of diseases with which patients were diagnosed. Thus, they were extracted from the original data set and stored in a separate file for further analysis. Of all the submitted ECs, office visits were most commonly coded, and accounted for over 180,000 for all age groups in the five-year period (2006-2010). Providing information and education was the second most common activity coded. We further divided the codes into sub-groups based on certain criteria.

Stage 3- Pattern Recognition

(a). Association between Encounter Codes and ICD-9 Codes

Usually NPs send to MoH each patient's visit info, which includes 1-3 ECs and 1-3 ICD-9 Codes. The combination of ECs and ICD-9 Codes defines the patient encounter and disease conditions. Thus finding the relationship between ECs and ICD-9 codes can help us to understand better not only the content of ECs, but also the most common diseases that patient may have, for example in different age groups. In the data set,

office visits were categorized into five ECs according to patient ages: 36300 (0-1), 36301 (2-59), 36302 (60-69), 36303 (70-79) and 36304 (80+). Visits for the 2-59 age group (code 36301) dominated throughout the five-year period. The 60-69, 70-79 and 80+ age groups were the second, third, and fourth positions in each year. The trend is possibly due to the actual population of each age group. The year-to-year comparison clearly indicated NP's visit trend. For all the age categories, the number of visits increased steadily to reach the maximum in 2009. Yet, in 2010, office visits dropped to the second most of all the years for all age groups. It is unclear why this happened.

(b). Top ICD-9 Codes for Different Age Groups

- Age 0-1 group - The leading reasons for babies (age 0-1) to see an NP were for a routine child health check (ICD-9 V202), and to monitor their growth and development (ICD-9 05A). Numbers of acute upper respiratory infections were similar to those for growth and development, and this was the third most common reason for NP office visits in this age group.
- Age 2-59 group - General symptoms (ICD-9 780), acute upper respiratory infection (ICD-9 460/ 462/ 465), diabetes (ICD-9 250), depression (ICD-9 311), hypertension (ICD-9 401), together with anxiety/depression (ICD-9 50B/3000) were the main visiting reasons in the 2 to 59 age (EC 36301). Other ICD-9 codes were relatively close to the leading ones. The top ICD-9 codes each had several hundred to several thousand visits. The age difference in this group is much wider than that of other age groups, which may, therefore, lead to the visit numbers being more equally distributed among the top disease/symptoms.
- Age 60-69 group - Data for the 60-69 age group (EC 36302) indicated the dominance of hypertension (ICD-9 401) and diabetes mellitus (ICD-9 250), with over 2,700 visits each in the five-year period. Other reasons for visits, such as malignant neoplasm, had only about 800 or fewer visits. It is worth noting that visits for acute upper respiratory problems were uncommon for this and other older age groups.
- Age 70-79 group - Again hypertension and diabetes mellitus were the main reasons for people aged 70-79 to visit an NP (EC 36303). However diabetes fell behind hypertension by nearly 800 visits over the five years.
- Age 80+ group - Hypertension was the leading reason in people aged 80+ to visit an NP. The visit number due to diabetes mellitus decreased further to about half the amount for hypertension patients, in comparison to the 60-69 and 70-79 age groups.

(c). Mental Health, Chronic Disease Management, and Patient Education

Mental health and chronic disease management are the two new ECs which are accessible to NPs since 2010. Although the records have only two-year history, the visits of these two ECs have been among the top 10 direct care activities spanning 2006 to 2010. In the top 20 ICD-9 codes, depressive disorder, anxiety states and anxiety/depression are the top 3 ICD-9 codes.

The MoH has three ECs associated with Chronic Disease Management: 36641 (1 condition), 36642 (2-3 conditions), 36643 (> 3 conditions). The current database includes 36641 and 36642. Our data set did not include 36643. For 1 condition visits, essential hypertension, diabetes mellitus and chronic renal failure are the top three ICD-9 Codes. Considering visits for 2-3 comorbid conditions, diabetes mellitus

becomes the most common ICD-9 Code followed by hypertension. This is a reversal of the pattern for younger age groups. Chronic renal failure remains in third place.

Patient education, EC 36380 (information provision) and 36381 (provision of educational materials), was frequently reported. These two ECs showed up as the second (73,698 counts) and third (28,748 counts) most common NP activities over the five-year period. Both 36380 and 36381 ECs were used during 2006 to 2008, but the latter was missed in the 2009 and 2010 year, presumably abandoned. Due to the similarity in the actual activity definitions of the two codes, we believe the two types of activities were combined in the last two years. Therefore to make a validated comparison, the activity frequency counts for both codes in the early three years were added together in the graph below. The bar graph demonstrates the top four education types, with at least 2,600 activities, that were relatively larger than other activities. Diabetes mellitus was the most common ICD-9 Code (n=5,866); essential hypertension next (n>4,300); and chronic renal failure was third (n=3,000+).

Stage 4- Pattern Validation

Finally, domain experts were involved to interpret if the discovered patterns have meaning in the targeted scenario. In this study, a nurse practitioner educator (Dr. Sangster-Gormley) and a health informatics expert (Dr. Kuo) worked together in the validation process to interpret the accuracy/meaning of the patterns. For example, there are different trends evident when comparing the three ICD-9 codes (401, 585 and 250) to visits among the different age groups. Essential hypertension (ICD-9 401) and chronic renal failure (ICD-9 585) visits increase with age, whereas diabetes mellitus peaks in the 60-69 age group and then decreases (ICD-9 250) as patients get older.

Table 1. Trend analysis of diseases

Rank	ICD9 Description.	36300 age 0-1	36301 age 2-59	36302 age 60-69	36303 age 70-79	36304 age 80+
1	401 Essential hypertension		2.7%	11.2%	13.3%	13.6%
2	250 Diabetes Mellitus		3.0%	10.9%	9.2%	6.3%
3	780 General symptoms	2.9%	3.6%	2.8%	2.6%	2.8%
4	585 Chronic renal failure			1.7%	4.5%	6.0%
5	465 Acute upper respiratory infections of multiple or unspecified site	9.4%	1.7%			
6	162 Malignant neoplasm of trachea, bronchus and lung			3.1%	3.9%	1.6%
7	820 Fracture of neck of femur			0.6%	1.0%	3.4%
8	311 Depressive disorder, not elsewhere classified		2.9%	1.2%	0.7%	
9	782 Symptoms involving skin and other integumentary tissue	2.2%	0.4%	0.7%	0.4%	0.9%
10	272 Disorders of lipid metabolism			2.1%	1.3%	0.6%
11	382 Suppurative and unspecified otitis media	3.5%				
12	428 Heart Failure				0.6%	2.7%

2. Results

Further to the information discovered in previous section, the study finds some interesting patterns as follows (see Table 1):

- (1). Hypertension morbidity increases with increasing ages;
- (2). Diabetes mellitus morbidity drops when people get older;
- (3). Chronic renal failure increases in higher age groups;
- (4). Depressive disorder decreases with increasing age;

- (5). Heart failure morbidity shows a similar trend to chronic renal failure and increases with age.

The patterns shown in Table 1 were interpreted as follows: "*As people age, chronic conditions take a toll on their health. Therefore, it was not surprising for us to identify these patterns. They help to confirm the types of patients for whom NPs are providing care. We expected younger people to exhibit depressive disorders more frequently than older adults. However, we cannot explain why the number of people with diabetes mellitus decreased with age*".

3. Conclusion

The study discovered the major patient groups and diseases that NPs have managed in the last five years. Elderly patients represent the major population served by NPs. Chronic diseases, such as diabetes and hypertension, were common reasons for older patients to visit NPs, while growth monitoring of children were common reasons for NP visits and this is not unexpected. NPs' communication skills, health promotion activities, and accountability have made for easy accessibility for patients with chronic disease. Therefore, the NP role can be seen as an important and positive addition to the BC health care system.

In conclusion, we have summarized key activities of NPs over the past five years. However, this is not an evaluation study because outcome information is not available. This is the first time that NP EC data were examined, and our analysis reflects the most common reasons for patient visits: patient education, mental health and chronic disease management visits, and therapeutic communication.

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