

Supplement

**Descriptive, cross-country analysis of the nurse practitioner workforce
in six countries: size, growth, physician substitution potential**

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1. Information on the literature scoping review

1.1 Background on literature scoping reviews

Literature scoping reviews have evolved over the last 20 years as an additional method to systematic literature reviews for searching the literature and synthesising the evidence on a specific topic, concept or research question [1-3]. While systematic literature reviews usually focus on narrowly defined research questions, usually following PICO elements (Participants, Interventions, Comparisons, Outcomes) [4], literature scoping reviews start at an earlier stage and with a broader scope, allowing for a broader approach to research questions or objectives [2, 3]. Research questions are therefore typically defined per PCC (Population, Concept, Context) instead of PICO elements [3]. According to Cacchione [1], there are three distinctive features of scoping reviews, first to map the research and key concepts underpinning a research question or concept, second, to provide a synthesis and analysis of a wide range of research and grey or non-research material and third, to include various, heterogeneous sources instead of focusing on the best evidence only.

We chose this study design to explore what evidence is available on the concept of physician substitution effect, measuring the extent to which NPs can substitute partially or fully for physicians. This research objective is relevant to workforce planners aiming at analysing the potential of NPs for expanding access and alleviating provider shortages in primary care, specific specialty areas or regions (e.g. rural and remote areas). We aimed to identify all existing evidence in the field, instead of restricting the review to Randomised Controlled Trials (RCTs) only. We followed the methods established by the Joanna Briggs Institute's manual on conducting scoping reviews [3].

1.2 Research questions, search strategy and data analysis

Review question(s)

The following research question guided the review based on the PCC elements (Population, concept, context):

What evidence exists on the concept of substitution, defined by Nurse Practitioners substituting fully or partially for physicians with a focus on primary care, focusing on studies conducted in six countries (Australia, Canada, Ireland, Netherlands, New Zealand, and the USA)?

Literature search

The literature search covered MEDLINE, CINAHL, Google Scholar, and grey literature, to identify what studies, concepts and literature exists that have quantified the extent to which NPs are able to substitute for physicians. We deliberately aimed to cover literature from peer-reviewed journals and grey literature to explore what information is available. In addition, we performed snowballing and asked country experts for additional information.

Inclusion criteria of the search:

- All studies (irrespective of the empirical method/methodology used) that quantify the extent of advanced practice of NPs to estimate their potential in substituting for physicians. The operational definition included the following: “studies calculating either the percentage of typical medical activities that can be safely performed by NPs; or methods on the extent of services that can be provided by NPs” [5, 6].
- The review was restricted to NPs only (Nurse Specialists in the Netherlands) working in primary care, such as family health, community health, including pediatric (routine) services, all primary care provider models (solo, group practices, health centres), including out-of-hours care, emergency ambulatory care
- Studies conducted in one of the following countries: Australia, Canada, Ireland, Netherlands, New Zealand, and the United States
- Search was conducted in English language
- No restrictions on years

Exclusion criteria:

- Studies that did not calculate in quantitative measures/terms the extent to which NPs can provide the same services as physicians, hence partially or fully substitute for physicians
- Studies conducted outside the six countries
- Inpatient care or specialty services, such as secondary and tertiary care, including hospital care, rehabilitation (if inpatient), psychiatric care if inpatient or outpatient, plus nursing homes
- Non-NP roles, such as Physician Assistants, Clinical Nurse Specialists, nurse anesthetists, nurse midwives, practice nurses, registered nurses.

Types of studies

All relevant studies were included that evaluate or analyse the potential physician substitution effect of NPs, including RCTs (randomised controlled trials), before-after studies, or any other studies with physicians as comparator groups, including studies published in peer-reviewed journals and grey literature.

Search terms used

Search terms included various combinations of the MeSH terms and individual search terms on the concept of physician substitution by nurse practitioners with a focus on primary care.

The following search terms were used:

Set #1 [NPs or similar advanced practice nursing roles]

"Nurse Practitioners"[Mesh] OR nurse practitioner* [TW] OR “advanced practice nurse” [TW] OR “advanced practice registered nurse” [TW] OR “advanced nursing practice” [TW] OR “nurse specialist” [TW] OR “nurse led” [TIAB] OR “nurse-led” [TIAB]

Set #2 [concept of substitution]

Substitut* [tw] OR visit [all] OR contribution [tw] OR task-shifting [tiab] OR task shifting [tiab] OR task sharing [tiab] OR delegation [tiab] OR re-allocation [tiab] OR forecasting [tiab] OR planning [tiab]

Set #3 [primary care]

"primary care" [Mesh] OR primary care [tw] OR community [tiab] OR primary health care [tw] OR community health [tw]

Combined Set 1 AND Set 2 AND Set 3

The search was conducted covering all years up to May 30, 2016.

Search results

The search yielded a total of 1,022 results (through databases, google scholar, snowballing and additional information by experts). After removal of duplicates (n=31), the titles of 991 records were screened according to the exclusion criteria. Of those, 768 were excluded, of which the major reasons were as follows: other, none NP roles (e.g. practice nurses, community nurses, nurse anaesthetists; or other non-physician roles, e.g. physician assistants, or a mix of different providers), no physician comparator group, no calculation or quantification of the “physician substitution potential” (e.g. percent of all visits performed by NPs, percent of physician tasks performed by NPs, etc). In a next step, the abstracts of 223 records were examined of which the full-text of 46 studies were screened. Out of those, five papers met the inclusion criteria and were relevant, as they had provided some form of quantification of the extent of substitution effect (three peer-reviewed journal articles, and two sources of grey literature) reporting findings from three different empirical studies. The search was conducted in English, however, snowballing and contacts with individual researchers resulted in few non-English publications, of which one Dutch report was included.

In addition, two reviews, published as a working paper and a book were identified [6, 7] that aimed at providing an overview of studies quantifying the percent of physician substitution potential. They were excluded from the main results because they included several groups of non-physician providers and did not exclusively focus on NPs. However, we provide an overview of the findings below to set our findings in context.

Data analysis and synthesis involved the extraction of information on the country, research aims, study design and year(s) of the study, service delivery settings, number and characteristics of participants, and the results. A narrative synthesis was performed, pooled analysis was not possible, due to the large heterogeneity of the studies and material identified.

2. Extent of NPs substituting fully or partially for physicians: overview of empirical studies

Table S 1. Detailed overview of empirical studies on the percent of physician substitution effect by NPs

Country	Aims/Purpose	Study design (Years)	Setting	Participants	Results	Reference
Canada	To assess the effects of substituting NPs for physicians in primary care	RCT (1971-1972)	Two large suburban Ontario family practices consisting of 1 physician and 1 NP each.	Families were randomised to care by a physician or NP. 529 families (1,398 individuals) randomised to each physician; 270 families (765 individuals) to each NP. Total patient N = 1,598 families (4,325 individuals)	67% of all primary care patient visits could be provided by NPs. Care delivery was similar between physicians and NPs. There were no statistically significant differences between patients seen by NPs compared with patients seen by physicians were found in patient functional capacity, indexes of social and emotional function, mortality, or satisfaction with care. Practices were able to increase practice size and patient volume with the addition of an NP in the practice.	[8]

The Netherlands	To compare the number of patients and caseloads between Nurse Specialists (<i>Verpleegkundig Specialist</i>) and GPs in out-of-hours services	Quasi-experimental study (April 2011 to July 2012)	Out-of-hours primary care	Intervention: one Nurse Specialist and four GPs, control: five GPs working in out-of-hours services. Total patient N=12,092 from one GP cooperative extracted from medical records	75-83% of clinical activities in out-of-hours primary care settings (weekend shifts in GP practices) could be taken over by Nurse Specialists. More than 77% of patients fit the scope-of-practice of Nurse Specialists in out-of-hours care. On average 16.3% of all patients were treated by Nurse Specialists, whereas 20.9% of patients were treated by GPs. GPs were more likely than NPs to treat older patients, patients with digestive, cardiovascular and neurological complaints and more urgent cases, whereas NPs treated more patients with skin and respiratory diseases.	[9, 10] [11]
USA	To assess practice activities of rural primary care physicians and NPs.	Self-report, mailed survey to a random sample of 4,000 physicians and 3,000 NPs with rural addresses (all specialties) (2011-2012)	Rural primary care in 13 states with at least 2 from each U.S. Census Regions (4 regions).	Final sample included 788 primary care physicians (response rate: 25%); and 918 primary care NPs (40%)	75-93% of weekly primary care outpatient visits can be provided by NPs. ^a In the outpatient setting, primary care clinical activities ^b were comparable between physicians and NPs in the outpatient setting. Average weekly outpatient visit quantity was 25% lower for NPs (p<0.001) than physicians, this difference decreased to 10% for NPs (P<0.001) compared to physicians in the multivariate analyses.	[12]

Source: see directly in the table

Notes: NP = nurse practitioners; RCT = randomised controlled trial; GP = general practitioner

^a In an unadjusted regression model, NP average weekly number of outpatient visits was 75% of physician volume. In an adjusted model (age, sex, geographic location, and practice setting), NP average weekly number of outpatient visits was 93% of physician volume.

^b On average, physicians conducted more well-child visits than NPs (12.6 vs. 7.4, p < 0.001). Differences for prenatal visits and minor procedures were non-significant.

Table S 2. Overview of reviews on the percent of physician substitution effect by NPs (and other non-physician providers)

Country	Aims/Purpose	Study design (Years)	Setting	Participants	Results	Reference
Reviews						
US-focused studies	To assess the delegation of primary care office visits to NPs and other “health practitioners”	Overview of studies (Dates of NP-focused studies: 1968-1974)	Primary Care – adult and pediatric	17 studies included with 7 focusing on delegation of visits to NPs.	75% of adult primary care and 90% of pediatric primary care can be safely delegated to NPs	[7]
International scope (studies from Canada, UK, USA)	To assess the percentage of physicians’ tasks that can be performed by nurses by synthesising the evidence on doctor-nurse substitution	Review of studies	All care settings	12 studies including several non-physician providers (including NPs, practice nurses, physician assistants) in intervention group	30 to 70% of the tasks performed by physicians could be performed by nurses or other non-physician providers (including NPs, registered nurses, practice nurses, other practitioners)	[6]

Source: see directly in the table

Notes: NP = nurse practitioner

3. Quality of the evidence

The quality of the records of studies included was highly variable, but mostly of limited quality. Of the five relevant papers, three were studies published in peer-reviewed journals, and two other sources were retrieved via google scholar and snowballing. The comparatively highest quality study was one study in Canada which findings stem from a small RCT involving two Ontario family practices [8]. The study shows the smallest risk of bias compared to the other literature, yet dates back more than 40 years and was based on a small provider base [8]. One more recent study, conducted in 2011-12 in the Netherlands was based on a quasi-experimental design, with moderate to high risk of bias, from which three papers reported findings [9-11] with the main paper being [11]. Of the remaining source included from the U.S., one recent study was based on a survey to over 7,000 physicians and NPs in rural areas, covering all specialty areas to assess the extent of practice, frequency of visits and primary care physician substitution potential [12]. Yet, its generalisability is limited, as it focused on rural practice. In conclusion, the evidence available to assess the extent to which NPs can substitute for physicians faces considerable limitations, is based on few studies, one of which dates back more than 40 years, calling for future research in the field.

4. References

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