Health Workforce Modelling, Northern Territory, Technical Report for the Nursing Workforce Model

Rosalyn Malyon

Yuejen Zhao

Steven Guthridge

DEPARTMENT OF **HEALTH AND FAMILIES**

Acknowledgements

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Abbreviations

ABS	Australian Bureau of Statistics
AHW	Aboriginal health worker
AIHW	Australian Institute of Health and Welfare
AR-DRG	Australian Refined Diagnosis Related Group
BoD	Burden of disease and injury
CDU	Charles Darwin University
COPD	Chronic obstructive pulmonary disease
DALYs	Disability adjusted life-years
DEST	Department of Education, Science and Training
DHF	Department of Health and Families
FTE	Full-time equivalent
HCSLF	Health and community services labour force
HGP	Health Gains Planning Branch, NT Department of Health and Families
IHD	Ischaemic heart disease
NT	Northern Territory
NTG	Northern Territory Government
PIPS	Personnel information and payroll system

Summary

The Northern Territory Nursing Workforce Model (the nursing model) projects the requirement for, and supply of, registered nurses and midwives (nurses) from 2006 to 2022. The nursing model was produced as part of the Health Workforce Modelling Project established by the Strategic Workforce Committee of the Department of Health and Families (DHF) to inform workforce planning by projecting future numbers of health professionals in the Northern Territory (NT).

Method

Growth in population and patterns of population ill health were used to project the future need for treatment and the nursing workforce required to meet that need. To estimate the supply of nurses, the current workforce was moved forward in time based on expected inflows and outflows of nurses and important trends and influences including migration, graduate numbers and ageing.

The key data sources for the model were:

- The Burden of Disease and Injury in the Northern Territory, 1999-2003 (Zhao Y, You J and Guthridge S, DHF)

- Population estimates (Northern Territory Government/Charles Darwin University)

- National hospital cost data (Australian Government, Department of Health and Ageing)

- Census data (Australian Bureau of Statistics, published by the Australian Institute of Health and Welfare)

- Nursing student data (Charles Darwin University)

Results

Key pressure points in the requirement for nurses were expected to be services to elderly Territorians, cardiology, oncology and neurology services. In geographic terms, the Darwin and East Arnhem areas were expected to experience the largest growth in the demand for nursing services.

The model indicated that growth in the requirement for nurses would exceed the growth in supply until 2015. After 2015 the situation would reverse largely due to increased inflows of local graduates from NT tertiary institutions. These inflows were also expected to increase the proportion of younger nurses in the workforce. The key risk to expanding the number of NT nurses will be the highly mobile nature of the workforce.

Despite the greater supply, the NT is likely to have substantially fewer nurses available to manage the per capita health need than may be available at a national level.

Conclusions

Based on past migration trends and the expected supply of local graduates, the nursing model initially projected a shortfall, but after 2015 the supply of nurses was expected to exceed requirements. Should supply exceed demand, there would be a greater number of nurses available to address the burden of disease and injury. This situation could

provide the opportunity to address unmet need and may contribute to closing the gap in health status between Indigenous and non-Indigenous Territorians.

The modelling highlighted the key impacts on growth. Most critical was the mobility of nurses. The modelling assumed that past migration patterns would persist into the future. Should the NT become less successful at attracting or retaining nurses, the resulting workforce will be very different to the projections. Another key flow into the workforce will be local nursing graduates. A potential risk for the NT was that the number of graduates may exceed the places available on DHF's graduate nurse program, leaving some graduates to find alternative pathways into the workforce or to consider interstate positions or other careers. Facilitating their entry into the workforce is important because more than the current numbers of graduates are needed for supply to meet demand in future years. The expansion of the workforce will also be dependent on the availability of funding to support growth in the public sector workforce.

The projections were developed to facilitate more sophisticated discussion in the NT about the demand and supply of nurses by highlighting minimum growth requirements, key areas of vulnerability in supply and emerging issues such as the placement of graduates. The modelling was, however, limited by the integrity and availability of current data sources. Better information on the current NT nursing workforce including graduates and further research on exits and re-entries into the workforce could enhance the modelling.

Introduction

Registered nurses and midwives (nurses) are the largest of the health professions and comprised 37% of the Australian health labour force in 2006.[1] With the proportion of nurses in older age groups increasing and a similar demographic transition in the Australian population expected to increase the demand for health services, there is much concern about whether the future nursing workforce will be sufficient to met the need for their services.[1,2] In the Northern Territory (NT), high turnover and the need to provide services in remote Indigenous communities compound these concerns.[3]

The Health Workforce Modelling Project was established by the Strategic Workforce Committee of the Department of Health and Families (DHF) to model the future requirements for, and supply of, health professionals in the NT. The project sought to address deficiencies in national models, in particular, inadequate recognition of the health needs of Indigenous Territorians and high turnover in the workforce.[4,5] Ethical approval for the project was obtained from the Human Research Ethics Committee of the NT Department of Health and Families and Menzies School of Health Research.

This report is the third publication from the project and focuses on the registered nurse and midwifery (nursing) workforce. It provides projections from the NT Nursing Workforce Model (the nursing model) of the supply and demand of nursing professionals. It also explains the technical approach, sources of data and the limitations of the nursing model. It should be read in conjunction with the technical report for the Medical Workforce Model (Medical Model Report), which provides more explanation on elements common to both models.

The report is structured as follows: first, the nursing model's information requirements, potential data sources and issues associated with the data are discussed. Second, projections from the demand and supply modules of the model and a gap analysis between the two are presented. This section includes discussion on the modelling approach, baseline projections and sensitivity analyses on key variables and assumptions in the modules. Third, pressure points with regard to specialty areas, specific demographic groups and regional areas are investigated, followed by an analysis of the adequacy of the current NT nursing workforce. Finally, the implications of the modelling are discussed and conclusions drawn.

Data parameters for the NT nursing workforce model

The nursing model projects the requirements for, and supply of, nursing professionals over the period 2006 to 2022. There are two components to the model: a demand module, which projects the future need for nursing services; and a supply module, which projects the future size and structure of the nursing workforce. This section of the report discusses the two modules in turn. The variables for each module are listed and an appraisal made of potential sources of data. Limitations of the chosen data source are noted and recommendations made for improvements.

Demand module data parameters

The demand module used a needs-based approach to project the requirement for nurses. Table 1 summarises the variables required for this approach and the data source for each variable used in the modelling. In the this module, the population variable provided an estimate of the NT population by age (nine groups: 0-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, and 75+), sex and Indigenous status. The health need variable provided an estimate of the level of ill-health for the 36 population groups across 185 categories of disease and injury. The data sources for these two variables were the same for the nursing and medical models so readers are referred to the Medical Model Report for the discussion on the potential data sources for the variables and the limitations of the source chosen for use in the module.

Table 1 Parameters and data sources for the demand module of the nursing model

Variable	Data source
Population	NT Government/Charles Darwin University estimates based on ABS data
Health need	Zhao Y, You J, Guthridge S. Burden of Disease and Injury in the Northern Territory 1999-2003. Darwin: DHF, 2009.
Nursing weights	Department of Health and Ageing. National Hospital Cost Data Collection, Cost Weights for Primary AR-DRG Version 5.1, Round 11 (2006-07), Northern Territory.
2006 nursing workforce	Number parameter from supply module.
Expansion factor	User defined (set at zero i.e., no expansion)

The groupings of disease and injury (burden of disease [BoD] groups) in the health need variable could comprise of more than one category of disease, for example, diarrhoeal diseases included bacterial, protozoal and viral intestinal infections. The necessary treatments for these BoD groups needed to be identified in order to determine the workforce required to meet that health need. The nursing model followed the approach of the medical model, which mapped the BoD groups to hospital treatments using Australian Refined Diagnosis Related Groups (AR-DRGs). Estimates of the nursing resources (nursing weights) required to treat an AR-DRG were available from costings of hospital separations through the National Hospital Costs Data Collection at a national and NT level. NT data were chosen to reflect NT workforce practices and the most recent collection (Round 11; 2006-07) was used in the module.

A starting workforce was required to translate the needs projection into numbers of nurses. The starting workforce was set at the headcount number of working nurses from the supply module to reflect the total number of nurses providing services regardless of their provision of hours.

The last variable in the demand module was the expansion factor, which provided the capacity for workforce planners to modify the requirement for nurses by a specified amount (to meet expected policy changes, technological advancements or other goals and developments). As with the medical model, it was set at zero (i.e., no expansion) in each year of the projection period.

Supply module data parameters

The supply module of the nursing model used a stock and flow approach to project the supply of nurses. Table 2 summarises the variables required for the supply module and the data source for each variable used in the modelling. The sources for data were similar to those used in the medical model for many items. Other potential sources and the logic for the chosen source are outlined in the following paragraphs. An estimate of the flow of local graduates was also required for the supply module and a separate component was developed to project their number.

Table 2 Parameters and data sources for the supply module of the nursing model

Variable	Data source
Number (headcount)	Working population – Australian Institute of Health and Welfare Health and Community Services Labour Force 2006 (AIHW HCSLF)
	Non-working population – Nursing Labour Force Census 2007
Age	AIHW HCSLF
Sex	AIHW HCSLF
Average working hours	AIHW Nursing Labour Force 2005
Full-time equivalent benchmark	NT Public Sector Nurses' 2008 – 2011 Union Collective Agreement
Graduates	Refer Table 3 for parameters and data sources for the graduate component of the nursing model's supply module
Immigration	ABS Census (multiple years)
Emigration	ABS Census (multiple years)
Retirement exits	ABS Retirement and Retirement Intentions Survey, Australia, Jul 2006 to Jun 2007, Cat no. 6238.0
Maternity exits and re-entry	Health Gains Planning (HGP) NT Midwives Collection, Mothers and Babies, 2005;
	HGP population estimates 2005, unpublished data based on ABS data;
	ABS Social Trends 2007, Article Maternity Leave Arrangements, Cat no. 4102.0
Mortality and morbidity	HGP, Fact sheet: Mortality in the NT, 2006.
Other exits	DHF exit interview data;
	AIHW Nursing Labour Force 2005
Working hours trend	AIHW Nursing Labour Force publications
Productivity trend	DHF Business Objects Database, Hospital Activity Reporting 5 year Universe; and Annual Reports

Number, age and sex of nursing professionals

The supply module required a profile of the current nursing workforce (the stock) segmented by age and sex in order to incorporate flows associated with these factors. The initial stock formed the foundation for the projection and influenced future flows. Accordingly, the accuracy and level of detail for the stock was important for the overall quality of the projection. Three potential sources for estimating the stock of NT nurses were identified:

- nurse registrations;

- Australian Institute of Health and Welfare's (AIHW's) Nursing Labour Force Census; and

- Australian Bureau of Statistics (ABS) 2006 Census.

To practise in the NT, nurses must be registered through the Health Professions Licensing Authority (HPLA). Practitioners may hold registration, but provide few or no services (e.g., retirees, those in non-clinical roles), temporary services (e.g., working holiday) or distant services (e.g., telehealth and other advisory services that may be located interstate). The age and sex of individual registrants could be obtained from the HPLA, but it does not record registrants' frequency or length of work in the NT. Furthermore, in each year nurses will leave the NT or not renew their registration for other reasons and these departures are not captured until the annual registration period. This omission means that the register may substantially overstate the number of nurses available in the NT. Indeed, in 2007 there was a 21% drop in the number of registrants after the annual registration period.[3]

The AIHW presents data on the Australian nursing workforce drawn from the Nursing Labour Force (NLF) census, which asks nurses renewing their registration demographic and labour force questions.[6] In the last publication, estimates for the NT in 2005 were not published due to a low response rate (14%).[6] No NLF census was conducted in 2006 and the results from the 2007 NLF Census had not been published at the time of the modelling. Access was, however, available to the raw data from the 2007 NLF Census as DHF administered it in the NT. Nurses participating in the Census were informed that the information was gathered for the purpose of national, state/territory and regional planning so its use was appropriate in this project.

Responses were available for more than 700 nurses who identified as working only or mainly in the NT. Although this number may be low relative to the number of registrants, it would have been equivalent to about 40% of the number of nurses likely to be working in the NT at that time.[3] The age and sex profile of these respondents could be used as a proxy for the wider population, provided there was no bias in the responses. When, however, the age profile of respondents was compared with the age profile from other sources, it showed a much greater proportion of older nurses. This result is consistent with anecdotal evidence that older nurses are more likely to respond to the survey than younger nurses.

The AIHW produces a Health and Community Services Labour Force (HCSLF) publication based on ABS census data. The most recent publication showed that at the time of the 2006 ABS Census there were 1888 registered nurses (including midwives, nurse educators, nurse researchers, nurse managers and clinical directors) in the NT.[1] Additional tables available on the AIHW website provided a breakdown of NT nurses by age (five-year grouping) and sex, making this source suitable for use in the supply module.

A further option for the starting stock would be to construct it from estimates of sub-sections of the workforce or limit the scope of projections to those sub-sections. Potential sources are the National Public Hospital Establishments data and DHF personnel records. These sources would, however, limit the analysis to the public sector and the data would have to be sourced by age and sex, which may incur costs and require ethics clearance each time the information is required to update the module. It may also omit nurses working in the public sector, but employed by nursing agencies rather than DHF.

The estimate from the 2006 ABS Census was higher than DHF estimates from a similar period,[3] which is consistent with it including nurses outside of the public sector. It was also available at a suitable demographic level. There are, however, a number of issues with using the ABS census as the data source for the stock of nurses. First, this source may overstate the typical number working in the NT because the ABS census occurs during the Dry Season, a period when workforce numbers tend to be higher.[3] Conversely, the census will not include nurses who provide visiting services to the NT and listed their usual place of residence as outside the NT.[3] It may also omit nurses for whom nursing is a secondary role and those who were not working in that role during the ABS census, for example, they were on maternity or study leave or working in a non-nursing role.[3]

It may be acceptable to omit those working in non-nursing roles as clinical services are the primary output of interest from a health needs perspective, but nurses on leave for other reasons who intend to return to the workforce need to be included. The responses to the 2007 NLF Census were used to estimate the size of this group in the absence of any alternative source, but it may be conservative due to the low response rate.

A final issue with ABS census data is that the supply module's stock can only be refreshed every five years. There was also a substantial delay between the 2006 ABS Census and the publication of the AIHW HCSLF (the 2006 data was not published until 2009). Data could be obtained earlier from the ABS, but a cost would be incurred. It may, however, be possible to reduce this cost by obtaining the information as part of a wider request by a number of agencies that wish to access workforce or other information from the census. Obtaining the data directly may also allow data to be obtained in narrower age groupings (ideally single year groupings), which would improve the modelling of ageing and retirements.

Should response rates to the NLF census increase or registration data improve with the commencement of the national registration scheme in 2010, these data sources could replace the ABS census as the data source in the supply module. Alternatively, data from the Department of Corporate and Information Services' Personnel Information and Payroll System (PIPS) could be used and the model restricted to projecting the DHF workforce.

FTE benchmark, average working hours and trends in working hours

The Full-Time Equivalent (FTE) benchmark is the average hours that a nurse would be expected to work in a full-time position. This information was used to count the number of FTE positions that were supplied in each year of the projection period and to determine the additional hours provided by actual workers. The FTE benchmark was set at 38 hours per week, which is consistent with the standard hours of a full-time public sector nurse (DHF is the primary employer of nurses in the NT).[7]

The actual hours worked are likely to differ by age and sex. There were two potential sources for data at this level – the NLF census and the ABS census. ABS census data would include hours worked in all jobs not just nursing roles and this data would need to be obtained at cost.[8] The NLF census captures this information, but the AIHW only publishes average working hours by age, although more detailed information could be obtained at a cost. The NT responses from the 2007 NLF Census were available to derive average working hours by age and sex for nurses who worked mainly in the NT. It generated average working hours of 42 and 37 hours for males and females, respectively. The average for all nurses was 38 hours per week. The most recent comparison from the 2005 NLF Census was 33 hours per week for Australian nurses. DHF data indicates that there is a gap of about 15% between the headcount and FTE numbers of nurses suggesting that the 2007 NLF responses may have been largely from full-time nurses.[3]

Trend data from past NLF publications showed that the average working hours for Australian nurses has increased in recent years, but no reliable trend was evident for NT nurses. The data also showed that male nurses were likely to work longer hours than female nurses and NT nurses tended to work longer hours than Australian nurses.

The average hours for Australian nurses from the 2005 NLF data were used in the module as the most reliable source, but it meant that average hours were set the same for males and females as the information was not publicly available for both. Males only comprise about one-tenth of the workforce so use of the same hours may not have a substantive impact on the results. The 2007 NLF data was used as a comparison in a sensitivity analysis. ABS census data could be obtained as a cross-check for NLF data in the future.

No provision was made for a change in average working hours because there was insufficient data to determine whether recent increases at a national level would continue. It is also possible that NT nurses are already working longer hours and have less capacity than their counterparts elsewhere in Australia to increase their hours.

Graduates

Two institutions provide undergraduate courses in nursing in the NT – Charles Darwin University (CDU) and the Batchelor Institute of Indigenous Tertiary Education (Batchelor). In 2006, 357 students commenced studies in nursing programs with these institutions – 30 at Batchelor and 327 at CDU.[9] Batchelor has a small nursing undergraduate program targeted at Indigenous students and only produced its first graduates in 2008.[10] The majority of its students are expected to be NT residents.[10] In contrast, CDU has a much larger nursing undergraduate program and most of its students are based interstate.[11] These students study using the external mode of learning, which means that they don't need to be based in the NT. How many relocate to the NT after graduation is unknown, but it is likely that they choose the course for the convenience of the study mode rather than because they plan to move to the NT. NT hospitals give preference to 'local' graduates (Australian students residing in the NT) when filling places on their graduate nurse programs, but at present they are insufficient in number to fill the available places. Remaining places are filled by interstate graduates with preference given to those studying with CDU.

Interstate graduates are less desirable than local graduates because they are likely to stay in the NT workforce for a shorter time. Their propensity to be mobile is shown by their preparedness to move to the NT. This propensity works against the NT, however, because they are equally willing to move away to pursue opportunities elsewhere if the

NT is unable to meet their needs. Ties with family and friends may also draw them back to their place of origin.

The large number of interstate students at CDU means that there is not a simple relationship between the number of university places and the expected flow of graduates into the NT nursing workforce. To account for this complexity, a separate component was developed to project the likely flow of local nursing graduates. Table 3 summarises the variables and data sources for the graduate component of the supply module.

Table 3 Parameters and data sources for the graduate component of the nursing supply module

Variable	Data source
Available tertiary places	Department of Education, Science and Training (DEST). Students 2007 [full-year]: Selected higher education statistics, nursing & prior years.
	Department of Education, Employment and Workplace Relations. New Commonwealth supported NT nursing place targets.
Proportion filled	Assume filled until 2008.
	From 2008 onward, places filled declines linearly over 5 years to estimate based on DEST, Applications, Offers, Acceptances and Unmet Demand Time Series, 2001-2008.
Attrition rate	Gaynor et al. (2008)[12]
Proportion part-time	CDU, unpublished data.
Proportion NT domestic students	CDU, unpublished data.
Course duration	CDU, standard completion timeframe
Actual NT domestic graduates	CDU, unpublished data.
Graduate nurse program intake	Royal Darwin, Alice Springs and Katherine hospitals, unpublished data.
Proportion female	CDU, unpublished data.
Proportion by age group	CDU, unpublished data.

The standard duration of an Australian undergraduate nursing program is 3 years full-time, 6 years part-time. CDU and Batchelor conform to this standard. The timeframe is shorter (2 years full-time) for enrolled nurses studying to become registered nurses as they have completed a vocational educational training program, which is credited against the first year of study under the bachelor degree. This entry stream was not identified specifically in the modelling due to a lack of data. Its likely effect, however, would be to bring forward the supply of nurses rather than increase their number unless enrolled nurses are more likely than other students to be resident in the NT.

Places on the CDU and Batchelor nursing programs are likely to be based on the number of Commonwealth funded places, places sponsored by the NT Government or other entities, and each institution's ability to attract full-fee paying students. CDU advised that it tended to fill available places as its external mode of study widened the potential student base.[11] In future periods, this may become more difficult as other institutions offer this study mode and clinical placements for interstate students become more difficult to secure. Batchelor had fewer places to fill and targeted Indigenous students.

To estimate the available tertiary places in the NT, the numbers of commencing students in 2006 and 2007 from the Department of Education, Science and Training student statistical collections were used.[9] These statistics were assumed to reflect the total number of places available in those years. The 2007 number of places was assumed to be available for the remainder of the projection period. Additional places were added based on information from the Australian Government Department of Education, Employment and Workplace Relations, which provided the numbers of new Commonwealth supported nursing places on tertiary courses.[13] Together, the new and existing places should provide a lower bound estimate of available tertiary places in the NT. Growth in full-fee paying students and places sponsored by entities other than the Australian Government was omitted as a data source for these places could not be found.

CDU and Batchelor indicated that places were presently being filled, but this may not be the case in future years if competition for students increases from interstate universities, potential students elect to undertake other studies or clinical placements are constrained. Between 2001 and 2008, only 78% of offers made (for all courses) by SA and NT universities were accepted.[14] This proportion was used to estimate the amount of unfilled places from 2012 onward. Between 2008 and 2012, the proportion of places likely to be filled was linearly reduced from 100% to 78% to give a transition between present circumstances to a situation where it is more difficult to fill available places in the NT.

Not all commencing students will complete their studies. A study by Gaynor et al. showed a three year attrition rate of 25% for Queensland nursing students and noted that this was similar to previous Australian attrition rates found in a systematic review.[12] Discontinuations at CDU in 2008 suggested a similar rate could be applicable in the NT.[11] Accordingly, Gaynor et al.'s estimate was used in the graduate projection.

The proportion of part-time and local students was based on an five-year average from CDU.[11] These proportions were applied to all institutions, which may bias numbers in a downward manner as Batchelor, with its focus on Indigenous training, may have a higher proportion of local students.[10] This choice was expected to have a small impact because Batchelor will produce relatively few graduate nurses compared with CDU.

International students account for about 5% of nursing students studying at CDU. International students were not included in the estimate of local students because it could not be ascertained how many entered the NT workforce at the end of their degree. The NT Government offers sponsorship to international students completing studies in needed vocations (after they have completed two years of study) and in return they are required to live and work in the NT for two years after receipt of their visa.[15] This requirement means that there may be some international students who are available to the NT nursing workforce upon completion of their degree, but informal enquiries suggested that their number were relatively small. Omitting these students could mean that the number of local graduates was understated, but it was not expected to have a significant impact on the projection.

The primary entry point to the nursing workforce in the NT is the graduate nurse program conducted at accredited training hospitals such as Royal Darwin and Alice Springs hospitals. NT hospitals provided data on the number of places on this program from 2006 to 2009. The number of places from 2009 to the end of the projection period was assumed to remain at the 2009 level. Interstate graduates who take up places on the graduate nurse program will be captured in the migration variable. As local graduates replaced interstate graduates on the program over the projection period, an adjustment was made to immigration numbers to account for this change.

Hospitals did not have demographic data on participants in the graduate nurse program and there was no flag to identify these nurses in PIPS. CDU, however, was able to provide data on the age and sex of graduates in 2008.[11] There were notable differences in the age structure between local and non-local graduates. Local students tended to be younger than non-local students – 52% were aged less than 30 compared with 30% in the non-local group. This difference may arise because the external mode of study is more suited to older students with families and other commitments. Other studies suggest that the younger age profile will be more typical of graduate nurses.[4,12]

Male students comprised 14% of local students and 12% of non-local students. There were also a greater proportion of local male students in the 30-34 and 40-44 age groups and less in the under 30 age group compared to local female students. The CDU age/sex profile for NT students was used in the graduate component of the supply module as it was more likely to represent the demographic profile of graduate nurses commencing in the NT workforce in future years as the hospitals will give preference to these students in filling their graduate nurse program. It would, however, be useful to collect demographic information on nurses in the graduate program to better inform the module.

The graduate component of the supply module projected graduate numbers from 2006 to 2022. CDU and Batchelor provided information on their actual graduates for the first three years of this period.[10,11] Had the module projected these numbers, similar figures would have been generated for 2006 and 2008, but the number for 2007 would have been too low.

Migration

Interstate and international migrants are key flows to and from the stock of nurses. Potential sources for migration flows were DHF exit interview data, registration board data, the Australian Government Department of Immigration and Citizenship (DIAC) and the ABS. Of these sources, ABS census data on present and past place of usual residency by professional group was used to calculate immigration and emigration rates for nurses. This source was chosen as it captured most forms of migration (excludes international emigration) and rates could be calculated at a suitable level of detail for the supply module. Readers are referred to the Medical Model Report for further discussion on the potential sources for the migration variable and issues with the chosen source.

Table 4 Migration rates for nursing supply module

Age group	Emigration	Immigration
Under age 30	0.30	0.39
30-39	0.18	0.18
40-49	0.10	0.09
50+	0.11	0.09

The one-year probability of immigration and emigration by 10-year age group had been determined for the past five censuses as part of the Nursing Mobility Study.[3] The average over the five censuses was used so that the estimates would be less sensitive to random fluctuations in any census year. Separate probabilities could not be

determined for female and male nurses. Averaging resulted in the probabilities shown in Table 4 being applied in the module.

Retirements

Ageing is a key concern with much of the nursing population being aged over 50.[6] Potential sources of data on exits due to age-related retirement include exit interviews, ABS data and studies on retirement from the literature. The ABS Retirement and Retirement Intentions Survey presents data on the age at which people intend to retire by age cohort, state or industry (health care and social assistance).[16] Intentions were available by age group, but not separately by males and females.

From the literature, Schofield and Beard analysed attrition in different cohorts of nurses based on ABS census data.[2] Attrition differed between cohorts with older cohorts tending to retire sooner than subsequent cohorts.[2] Retirement rates tended to be higher than those generated from the ABS Retirement and Retirement Intentions Survey using whole of population data. Bacon studied the dynamics of work and retirement using the ABS Retirement and Retirement Intentions Survey 1994.[17] This study provided figures for both age and sex, but the information was rather dated.

Consistent with the medical model, the ABS data was used to determine retirement rates for the nursing supply module and rates were set the same for female and male nurses. Although based on the whole of population rather than nurses specifically, the survey is likely to be conducted regularly thereby allowing the module to be updated to incorporate present intentions. Retirements were assumed to occur in nurses aged over 45. No age related retirements were assumed to occur below 45 years of age. In the final age group (65+), all nurses were assumed to retire after their 70th year as there were relatively few working past this point.[1] The rates derived from the ABS data are shown in Table 5.

Table 5 Retirement rates for nursing supply module

Age group	Males	Females
45-49	0.02	0.02
50-54	0.02	0.02
55-59	0.02	0.02
60-64	0.07	0.07
65+	0.17	0.17

Maternity

Maternity absences were calculated using the approach and data sources from the medical model. This approach applied the proportion of women likely to have a birth, the proportion of birthing women likely to take leave for maternity, the average length of maternity leave and the proportion of women who return at the end of their leave. This data was based on the general population (non-Indigenous). The proportion of women who take leave was 73% and the average duration of leave was 34 weeks. No data were available on the proportion of women returning from leave so this was set at one (i.e., all return). No allowance was made for paternity leave by male nurses. For further information on the approach to calculating maternity exits and re-entries including its limitations, readers are referred to the Medical Model Report.

Mortality, morbidity and other exits and re-entries

Non-indigenous death rates in the NT indicate that in the current population of 495 nurses aged over 50 years there would be about five deaths per annum.[18] This estimate was based mortality in the general population. DHF exit interview data indicated that 27 nurses departed due to health reasons over a period of eight years (an average of 3 per annum). Deaths were not recorded, but if these figures are representative, they would indicate that less than 1% of the workforce would depart each year due to mortality and morbidity. The supply module has the capacity to include exits due to mortality and morbidity, but it is not clear that they occur to such an extent as to substantially refine the projection. Rather, their inclusion may simply increase uncertainty with little change to the overall numbers.

More generally, the exit interview data showed that another 54 nurses (3% of the 2006 ABS Census population) left due to study, poor work environment and other reasons; however, this may understate the extent of exits and their nature because exit interviews are not compulsory. It is reasonable to expect that nurses will depart from the workforce for reasons other than maternity leave and to migrate interstate or overseas; however, better data on the extent of such departures and who tends to depart (e.g., their age) was required.

The responses to the 2007 NLF Census indicated that there are also nurses re-entering the workforce after an absence although no detail was available on the reason for their absence. Across Australia, the 2005 NLF Census indicated that about 1% of non-working nurses were seeking to return to work in nursing.[6]

Preston used an all-inclusive approach to estimating exits from the nursing workforce. Her 'net separation' approach used 2001 ABS Census data to determine the change from one year to the next in the percentage of people with professional nursing qualifications who were still working as registered nurses.[4] This approach implicitly captured exits for age, ill-health, family considerations, etc as well as re-entries. It yielded net separation rates of about 4% for nurses aged under 30 years and the 50-54 age group, 1% or lower for nurses aged between 30 and 49, 8% for the 55-59 age group and 19% for the oldest age group (60-64).[4] Preston noted that net separation rates in the NT were relatively high and increased its net separation rates by 1% to account for this phenomenon.[4]

Preston's rates indicated that allowing for migration, maternity and retirements alone may not sufficiently account for exits from the NT workforce. DHF data supported the existence of other exits and a sizeable number of nurses responding to the 2007 NLF Census indicated that they had re-entered the workforce. Accordingly, an exit rate of 3% based on DHF data and a re-entry rate of 1% based on 2005 NLF data were applied across all age groups in the supply module to account for other departures and re-entries that occur in the nursing workforce. Preston's rates were used to conduct a sensitivity analysis. Further research is recommended on the extent, nature and age profile of exits from the nursing workforce to refine this variable.

Productivity

The output (productivity) of nurses will be influenced by their hours of work and their abilities. Changes in productivity that occur due to changes in the hours of work were addressed by the trend variable for average hours of work, discussed previously. The productivity variable adjusts for other factors, for example, reductions in the number of patients attended due to increasing acuity or a less experienced workforce; or increases in productivity as a result of workforce reform or the introduction of new technology.

A crude measure of productivity based on separations and FTE nursing staff drawn from DHF's Annual Reports was used to evaluate whether there had been notable changes in output in NT hospitals. The data showed that the number of same-day and multi-day separations per nurse was similar between 2005-06 and 2007-08. There was more variation in the number of weighted separations per nurse, but no clear pattern could be discerned. None of these measures allowed for changes in the quality of services provided or patient outcomes.

The productivity variable was set at 1 in the supply module (i.e., no change in productivity), but further development and measurement of this variable is recommended. Key impacts likely to affect productivity are increasing acuity in an ageing population, new technology or work practices and changes in the stability of the workforce.

Projections from the nursing model

Demand module

The demand module used a needs-based approach for the projection of workforce requirements to capture the health differential between sub-groups in the population. It used growth in population and patterns of population health to project the future need for treatments and thus, the required workforce to meet that need. The techniques used in the application of this approach were identical to those in the medical model and readers are referred to the Medical Model Report for further detail. This section of the report outlines the assumptions of the nursing demand module and presents a projection from 2006 to 2022 of the requirement for NT nurses. The sensitivity of the projections to changes in the key variables is also discussed.

Modelling techniques and assumptions

Following the approach of the medical model, health need was determined for key demographic groups (age, sex and Indigenous status) by BoD group. Nursing weights were derived using the methods outlined in the Medical Model Report and applied to the total health need for each BoD group to give the nursing requirements. The requirements were then totalled for all the BoD groups to give the total nursing requirement for each year in the projection period. To project the required workforce, growth in nursing requirements between periods was applied to the nursing workforce from the previous period. The headcount number of nurses from the supply module was used as the starting workforce in 2006.

Table 6 shows the assumptions underpinning the demand module. These assumptions were the same as those for the medical model and a more extensive discussion is provided in the Medical Model Report.

Table 6 Assumptions in the nursing demand module

Variable	Assumptions
Burden of disease and injury (BoD)	No change in incidence, severity and duration of disease over projection period.
Nursing weight	Workforce requirements are the same across health sectors (primary, secondary and tertiary) and types of staff (e.g., part-time, full-time). No technology impacts, workforce substitution or redesign. Current treatments are efficient.
2006 nursing workforce	2006 workforce meets the health needs in that period.
Expansion	No additional growth in future periods.

Key issues with the assumptions are:

- Constant BoD may be unrealistic if improvements in survival are meaning more people live longer with chronic conditions or initiatives to reduce the health gap between Indigenous and non-Indigenous Territorians are successful in reducing disease and injury in the Indigenous population.

- Reducing BoD may not be associated with decreased requirements for nurses. Rather, the focus of health care may change from restoring to maintaining health

(e.g., increased emphasis on preventive health) or to achieving greater levels of 'healthiness'.

- Workforce requirements in other sectors may be different from the hospital sector due to the less acute nature of cases (e.g., public health), the type of patient (e.g., aged care) or other factors.

- The workforce in 2006 may not have been sufficient to meet health needs. The presence of the health gap suggests that 'needs', particularly in the Indigenous population, were not being adequately met.

Projections of the demand for nurses

A baseline projection of the requirement for nurses in the NT is presented in Figure 1. Over the 16-year period, the BoD was projected to increase by 51%. Growth in the requirement for nurses was the same with numbers increasing from 1888 in 2006 to 2849 nurses in 2022. In 2006, the major contributors to the BoD were: type 2 diabetes (11%); anxiety and depression (9%); ischaemic heart disease (IHD; 8%); chronic obstructive pulmonary disease (COPD; 4%); and road traffic accidents (3%). In 2022, diabetes was still the leading contributor, but IHD had become the second greatest contributor and road traffic accidents was replaced by renal disease (nephritis and nephrosis) as the fifth largest contributor to the BoD.

Figure 1 Demand for NT nursing workforce, 2006 to 2022
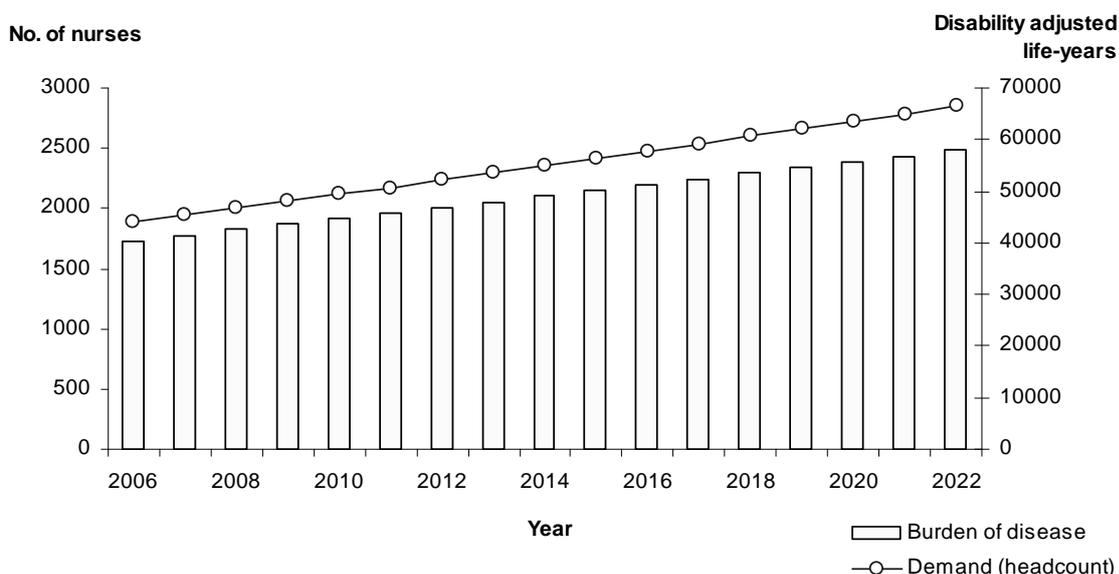
This movement was due to the larger growth rates in IHD and renal disease (64% and 69%, respectively) compared with anxiety and depression and road traffic accidents (23% and 25%, respectively). The growth in BoD from type 2 diabetes was 52%. Other BoD groups including eye diseases, other mental disorders and some types of cancer had larger growth rates, but they made only small contributions (less than 1%) to the overall burden even by the end of the projection period.

In terms of the need for nurses, the top five areas of requirement in 2006 were diabetes, IHD, COPD, lung cancer and stroke. Together they accounted for 34% of nursing requirements. By 2022, these BoD groups still remained in the top five, but

their contribution to the nursing requirement had risen to 37%. Aboriginal Territorians accounted for 52% of the nursing requirement in 2006, despite their comprising less than one third of the population. This contribution was similar in 2022 and there was only a small increase in their population proportion.

Sensitivity analyses

Analyses were conducted on key variables of the demand module to determine the sensitivity of the results to changes in inputs and methods. Issues investigated were: greater growth in the NT population; the use of different nursing weights; and an increase in chronic disease. The results of the needs approach were also compared with projections from a trends approach.

Table 7 shows the results of the sensitivity analyses. A 'high' population estimate based on greater levels of net interstate migration was projected by Northern Territory Government/Charles Darwin University. In the high estimate, the population was 8% higher in 2022 than in the baseline estimate. Use of the high estimate progressively increased the nursing workforce requirement over the projection period and culminated in a 4% increase (112 more nurses) in requirements by 2022. The lesser increase in demand relative to the increase in population is likely to be due to immigrants tending to be of working age and in relatively good health. If the population were to increase due to other causes such as a rise in births, particularly in the Indigenous population, the impact on demand may be more substantial.

Table 7 Summary of sensitivity analyses on variables in the nursing demand module

	No. of nurses				Difference from baseline		
Scenario	2006	2014	2022		2006	2014	2022
Baseline	*1888*	*2357*	*2849*				
Population – high migration	1888	2395	2961		0%	2%	4%
National nursing weights	1888	2304	2732		0%	-2%	-4%
Increase chronic disease 5%	1888	2359	2854		0%	0%	0%

Nursing weights based on national rather than NT data were used in the model to investigate whether there may be structural or other arrangements in the NT that influenced the requirements for nurses. Use of national nursing weights reduced the workforce requirement in 2022 by 4% (117 fewer nurses).

A key concern is the impact of chronic disease. If incidence rises (due to better diagnosis or the impact of lifestyle risk factors such as obesity) or prevalence increases with improvements in survival, there may be a greater demand for nursing services. To show the relative impact of an increase in chronic disease, the BoD for heart disease, diabetes, cancer and chronic respiratory disease groups were increased by 5% and maintained (no further increases) throughout the projection period. It resulted in a small increase of 5 more nurses in 2022.

## Alternative projection methods

In the medical model, the needs approach was compared to an utilisation approach and a trends approach. As expected, the utilisation approach yielded a lower estimate of growth, which was consistent with that approach being influenced by access, funding and other constraints rather than the need for services based on health conditions. An

estimate based on the utilisation approach was not conducted for the nursing workforce as this information was likely to be of limited use.

The trends approach provided a useful contrast to the needs approach as it reflected past service expansion (the provision of more services per capita) regardless of the driver of that growth. This approach provided an upper bound estimate of future requirements assuming services continued to be expanded at past rates. It used historical growth in separations and the relationship between nurse numbers and separations to project the demand for the nursing workforce. Data sources were the DHF Business Objects corporate reporting tool and DHF annual reports. Annual growth in separations ranged from 2% to 10%. Over a 13-year period, the compound growth rate was 6%. A regression analysis showed that for every 1000 additional separations, the FTE number of DHF nursing staff was likely to increase by 13 persons (R^2=0.957).

As shown in Figure 2, the trends approach estimated that 3584 nurses would be required in 2022, 26% more than the needs approach. Despite the substantial difference, this approach could still be generating a conservative estimate of nursing requirements. Despite past growth in the health workforce, there has been limited progress in bridging the health gap between Indigenous and non-Indigenous Territorians. For the gap to narrow by a more substantive amount,[19] much higher growth in the health workforce may be needed.

Figure 2 Needs and trends projections of the NT nursing workforce, 2006 to 2022
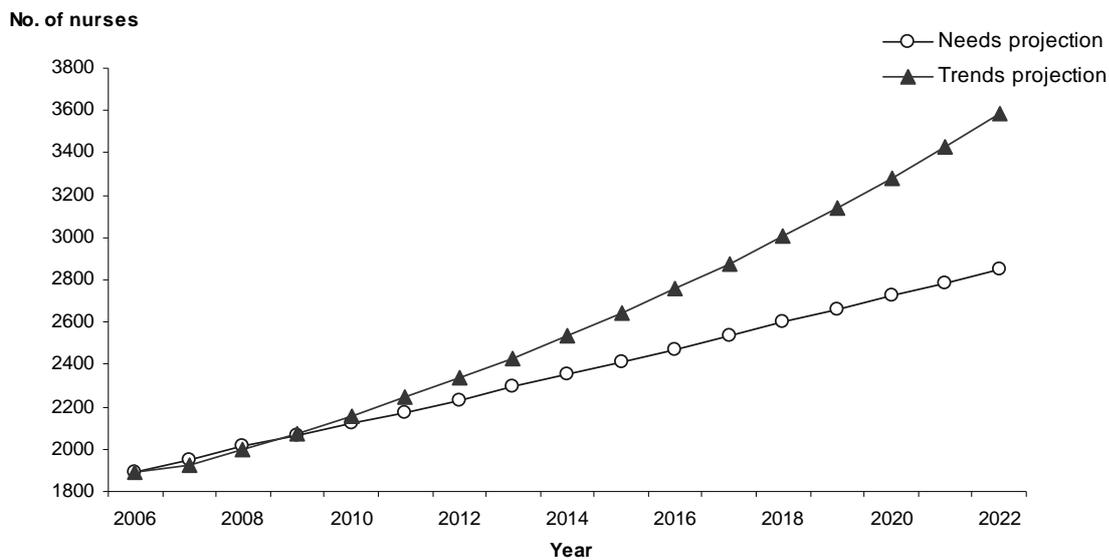
Supply module

The supply module used a stock and flow approach to project the supply of NT nurses. This approach identified the size and activity of the current workforce (stock), sources of inflows and outflows from the stock, and important trends or influences on the stock and flows. To project future supply, the initial stock was moved forward based on expected inflows and outflows and allowing for the impact of important trends and influences on the stock. The following sections explain the techniques and assumptions used in this approach and present a projection of the supply of NT nurses for the period

2006 to 2022. The sensitivity of the projections to changes in the key variables is also discussed.

Modelling techniques and assumptions

The stock of nurses consisted of males and females divided into ten age groups (<25, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64 and 65+). The headcount number of nurses in the initial year of the project was the number of working nurses. Provision was made for a non-working population and it was assumed that this population would return to work in 2007 and be subject to flows during that period. No provision was made for the existence of a shortfall in the initial stock. This omission effectively assumed that current workforce was producing the intended level of services. Table 8 lists these and other assumptions of the supply module.

Table 8 Assumptions in the nursing supply module

Variable	Assumptions
Number	The initial non-working population returns to work in the next year.
	The current workforce is producing the intended level of services.
Age	1/5 of an age group is moved to following age group each year.
FTE benchmark	No change in average hours of full-time nurse
Graduates	Number of commencing places in 2007 is available for entire projection period.
	Increases in undergraduate places end in 2012 and the no. of places stays constant for the remainder of projection period.
	All university places were filled until 2008. Filled places decline linearly over 5 years from 2008 to 2012 to average levels (SA/NT).
	The number of places on DHF's graduate nurse program remains constant over the projection period.
	Graduate nurses are able to enter the workforce through paths other than the DHF graduate nurse program.
	Maternity and exits for other reasons are not applied to graduate nurses in their first year.
Immigration and emigration	No gender differences in migration rates
Retirements	Retirements start from age 45 onward.
	No gender differences in retirement rates.
	All nurses have retired by age 71.
Maternity	All women return from maternity leave.
	No males take parental leave.
Other exits and re-entries	Assumed to be the same for all age/sex groups

In each year of the projection, the module applied emigration rates to the workforce of the previous period (including maternity and other exits who are assumed to re-enter) to account for interstate movements. The remaining workforce was then aged one year by moving one-fifth of each age group to the following age group. In the 65+ age group, one-sixth of the group were removed to account for retirement at 70. Adjustments were made for maternity leave, retirements and other exits. Graduates were added then the total number of nurses was divided by the probability of not being an immigrant (one minus the probability of inward migration).

After the immigration calculation an adjustment was made to account for a reduction in interstate graduate nurses. It was estimated that in 2006, 51 graduate nurses would have come from interstate and be included in the immigration rate for that year. Interstate graduates would have also been included in rates from previous censuses. The graduate immigration adjustment estimated the number of interstate graduates required to fill places on the graduate nursing program. This number diminished over the projection period as more local graduates were produced. The difference between the number of interstate graduates in 2006 (51) and the number of these graduates in each year was deducted from the workforce numbers except in the first three years of the model. Application of the adjustment in those years had little impact on the size of the workforce, but DHF data indicated that expansion occurred. It is likely that no adjustment was made for an increase in local graduates (higher immigration rates were maintained) so the graduate adjustment was omitted in the three years prior to 2010.

In the graduate component of the demand module, a subtraction method was used to estimate the number of local graduate nurses. The number of undergraduate places was estimated using 2007 commencements and new places coming on stream in subsequent years. From this figure, a deduction was made for unfilled places. Prior to 2008, places were assumed to be filled. From 2008 onward, the proportion of unfilled places increased at in a linear rate to reach 22% in 2012. Thereafter, the proportion of unfilled places was kept constant. Expected attrition was then allowed for with only 76% of commencing students expected to complete their nursing course. International and students residing in other states were removed and the remaining local students apportioned between part-time and full-time study. The number of local graduates in each year of the projection comprised of part-time students who had started 6 years previously and full-time students who had started 3 years previously. For example, in 2010 the number of local graduates comprised of part-time students who started in 2004 and full-time students who started in 2007.

The final stage of the supply projection was to adjust for productivity changes. No changes were made in the module because there was insufficient evidence of any long term trends in average working hours or other productivity measures. The capacity exists, however, for average working hours and the actual numbers of workers to be increased or decreased to account for changes in productivity.

The module calculated three estimates of nursing numbers: headcount, FTE supply and FTE resources. FTE supply measured the number of FTE workloads being performed by the workforce and FTE resources showed the actual FTE number of workers.[20] The FTE benchmark was 38 hours so a nurse who worked 45 hours would be one FTE under the FTE resources method and 1.2 FTE under the FTE supply method. A nurse who worked 19 hours would be 0.5 FTE in both models. The difference between FTE supply and FTE resources represented the extra hours contributed by the workforce.[20] Reductions in the average hours worked or growth in the proportion of middle (child-rearing) or the oldest age groups of nurses who typically work shorter hours would be expected to reduce the extra hours contributed by the workforce.

Projections of the supply of nurses

A baseline projection of the supply of nurses in the NT is presented in Figure 3. It shows the headcount numbers, FTE supply and FTE resources over the period 2006 to 2022. Over the 16-year period, the number of nurses was projected to increase by 66% from 1888 practitioners in 2006 to 3124 in 2022. The gap between the headcount and the FTEs supplied by nurses (FTE supply) widened from 221 FTE in 2006 to 336 FTE in 2022. The additional labour provided by the actual FTE workforce (FTE supply minus

FTE resources) was small and only changed slightly over the projection period with 3 additional FTEs being provided in 2006 and 10 in 2022. The slight increase reflected the change in the age structure of the workforce to a greater proportion of younger nurses who tend to work slightly more hours.
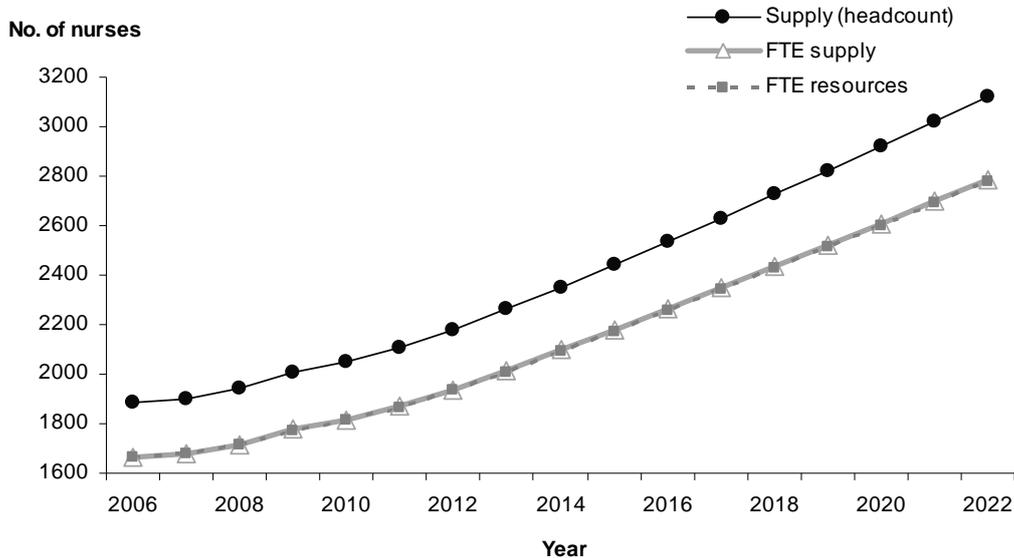
Figure 3 NT nursing workforce supply, 2006 to 2022

Figure 4 shows the change in the age distribution of the workforce over the projection period. The key area of change was the increase in nurses aged under 40 years compared with those over 40 years. In 2006, 44% of the workforce was aged under 40, but by 2022 it increased to 64%. This change was driven by the inflow of graduate nurses who were mostly in younger age groups, positive net migration in the 30-39 year group and the exit from the workforce of older workers due to retirement and emigration.

Figure 4 Age distribution of NT nursing workforce, selected years: 2006, 2014 and 2022
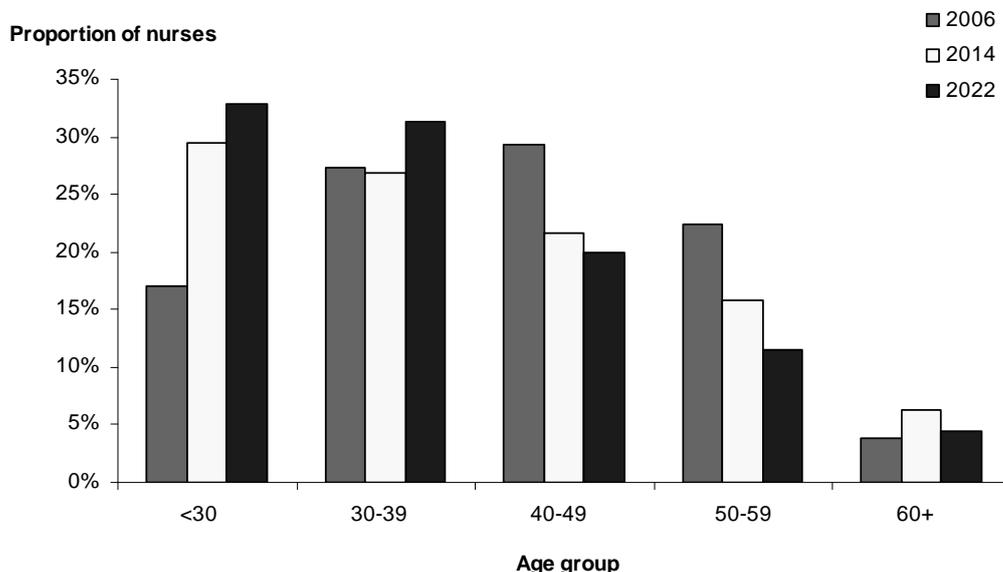
The proportion of males in the NT nursing workforce was expected to increase slightly with their proportion rising from 11% in 2006 to 13% in 2022. The increase was driven by the sex distribution of graduates where the proportion of male students is higher than the proportion of male nurses in the workforce. Mobility did not affect the ratios as migration rates were the same for males and females.

Local graduates were a key flow in to the NT workforce. Figure 5 shows the projected number of undergraduate places, expected local graduate numbers and places available on DHF's graduate nurse program between 2006 and 2022. By 2011, tertiary institutions in the NT were expected to be able to offer more than 600 undergraduate nursing places to prospective students each year; however, most students would be from interstate or overseas countries. A maximum of 130 local students per annum were projected to graduate from these institutions during the study period.

Figure 5 Local nursing graduates, 2006 to 2022
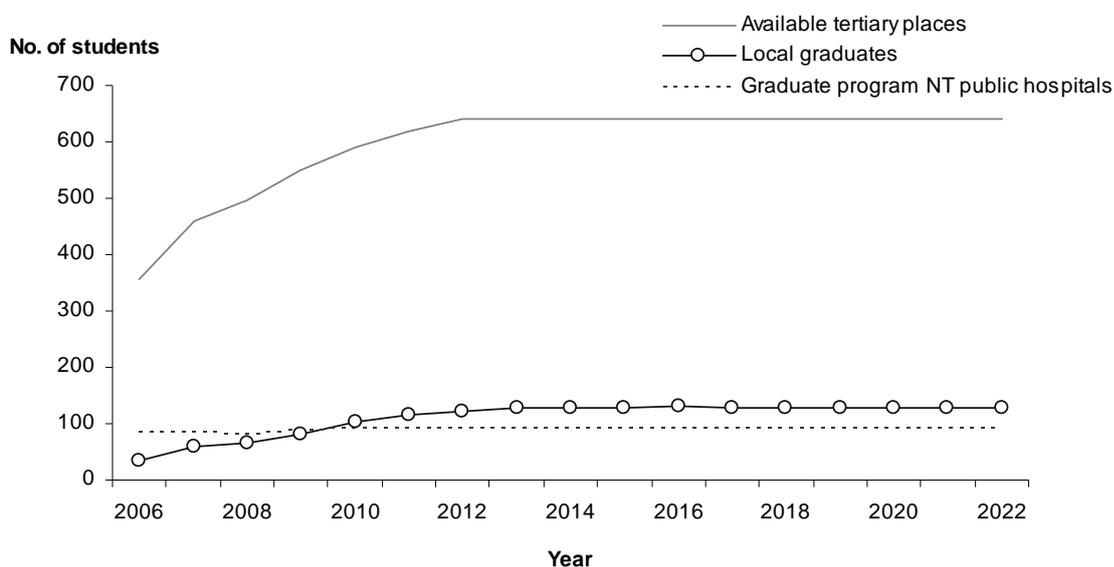
The number of places on the DHF graduate nurse program was held constant from 2009 onward (the slight variation in earlier years reflects actual numbers on the program). This assumption meant that by 2010 the number of local graduates exceeded the number of places available on the program. In later years of the projection period up to 40 graduates each year may be seeking to enter the workplace through alternative means if places are not expanded on the DHF program.

Sensitivity analyses

Sensitivity analyses were conducted to investigate the impact on the projections of changes in key variables and assumptions in the supply module. Scenarios relating to the following factors were analysed: graduate numbers, working hours, mobility trends, maternity leave, retirements and other exits. The module was found to be extremely sensitive to the inclusion of other exits and re-entries and changes in the estimates of graduates and migration rates. Table 9 summarises the results from the analyses.

Although there are exits from the workforce for reasons other than maternity and migration, nurses who resign are likely to be replaced by either a returning nurse, a part-time or casual nurse seeking a permanent place or an interstate or international

migrant. Thus, an exit would be a temporary loss to the workforce rather than a permanent loss. If there were no exits or re-entries allowed for other than maternity and migration, there would be another 576 (18%) nurses in 2022. This scenario does, however, assume that the NT can continue to attract and retain nurses at past levels.

Table 9 Summary of sensitivity analyses for the nursing supply module

Scenario	Headcount				Difference from baseline		
	2006	2014	2022		2006	2014	2022
Baseline	*1888*	*2353*	*3124*				
No exits and re-entry	1888	2625	3700		0%	12%	18%
Graduates – no excess [a]	1888	2140	2411		0%	-9%	-23%
Graduates – no unfilled places [b]	1888	2428	3637		0%	3%	16%
Graduates – older	1888	2191	2613		0%	-7%	-16%
Maternity – all take, four year return	1888	2254	2937		0%	-4%	-6%
Retired at 66 years	1888	2328	3097		0%	-1%	-1%
Mobility zero	1888	2156	2480		0%	-8%	-21%
Mobility 10% less immigrants	1888	2009	2384		0%	-15%	-24%
Mobility 2006 rate	1888	2816	5060		0%	20%	62%
Preston re-entry rates	1888	2306	2732		0%	-2%	-13%
	FTE supply				Difference from baseline		
Scenario	2006	2014	2022		2006	2014	2022
Baseline	*1667*	*2098*	*2788*				
NT average working hours	1856	2332	3091		11%	11%	11%

[a] Graduate numbers limited to places available on DHF graduate nurse program
[b] All undergraduate places in NT tertiary institutions are filled

In 2006, 84 graduate nurses entered the NT workforce through DHF's graduate nurse program; an increase of nearly 5% in the size of the workforce. By the end of the projection period, it was expected that about 130 local graduates would be seeking to enter the NT workforce (4% increase in workforce). If the number of places on DHF's graduate nurse program remained the same, surplus graduates would have to find other entry points into the workforce. If it is not possible for them to do so or the number of local graduates is lower than expected (attrition is higher or there are fewer local students), it will reduce the size of the nursing workforce. If the number of graduate nurses entering the workforce each year was limited to the number of places on the graduate nurse program (90), there would be a 23% reduction in the number of nurses in 2022 (2411 compared with the baseline of 3124) and demand would exceed supply by 438 nurses.

The previous scenario shows the risk to the NT of insufficient graduates; however, the opposite circumstance may occur where there may be more local graduates than expected. A conservative estimate was made of the proportion of tertiary places that could be filled in future years (78% from 2012 onward). Should NT institutions be able to fill all places on their nursing courses (no change in the proportion of local and non-local students), the NT workforce could be 16% higher (513 more nurses) in 2022. If

the proportion of local students were to also increase, growth could be greater as long as graduate nurses can successfully transition into the NT workforce.

The age of graduates will affect their longer term impact on the workforce. Some older graduates were expected (8% over age 45), but more than 50% of local graduate nurses were expected to be under 30 years of age. Younger graduates would be available to the workforce for most of the projection period (assuming they remain in the workforce). The age profile of interstate and international nursing students was markedly different, however, from local students. Of these students, 26% were aged 45 years and over and only 25% were aged under 30. If this age distribution was more representative of the graduates entering the NT nursing workforce there would be 511 (16%) fewer nurses in 2022 than in the baseline projection.

The nursing workforce is predominantly female so an important form of exits will be maternity leave. These exits may have been conservative because public sector nurses would be entitled to take 52 weeks of leave (14 paid weeks) and potentially up to six years of unpaid leave.[7] These conditions may encourage a greater number to take maternity leave. Nurses who take maternity leave may also exit for a longer period of time than suggested by the national data on maternity exits. Responses to the 2007 NLF Census indicated that nurses aged between 30 and 50 who re-entered the workforce tended to have been absent for three to four years. If the maternity variables were changed so that all pregnant nurses took leave (no change in the proportions likely to have a birth and returning after a birth), the number of nurses in 2022 would be reduced by 3%. If their return to work was staged over four years, the reduction in the number of nurses doubled to 6%. Combined, there would be 187 fewer nurses in 2022 than in the baseline projection.

A source of concern for workforce planners is the ageing of the workforce and the retirement decisions of different cohorts of workers. Nurses were assumed to start exiting the workforce for age related reasons from age 45 onward and all were assumed to have exited by the end of their 70th year. Reducing the retirement age to 65 lowered the projected number of nurses in 2022 by 1%. The relatively small impact is due to the outward migration of older nurses (aged over 40) and large retirement exits in the 60-64 age group such that relatively few nurses aged over 65 were still in the workforce.

Mobility in the nursing workforce is high. Net migration was positive for nurses aged under 40 and negative for those aged over 40.[3] These patterns increased the size of the workforce and offset the impact of ageing. Had there been no migration (except graduates in early years of the projection) there would have been 644 (21%) fewer nurses than in the baseline projection. The age structure of the nursing workforce would be differ substantively with 46% of the workforce being aged under 30 (compared with 64% in the baseline projection) and 27% of the workforce being aged over 50 (compared with 16% in the baseline).

Changes in the migration probabilities have an even greater impact because as the workforce grows, the number of movements increases and there are impacts on maternity and retirement exits with changes in the age structure. Reducing the number of incoming nurses by 10% (a two percentage point reduction in the probability of having arrived in the NT) and no change in outflows decreased the number of nurses in 2022 by a greater amount than in the case of no migration. It resulted in 740 (24%) fewer nurses in 2022 than in the baseline projection.

Inward flows may, however, be greater as was the case in 2006. The 2006 data also enabled migration probabilities to be calculated separately for male and female nurses. It showed that in 2006 female nurses were less likely to come to or leave the NT than

male nurses. Net migration was also positive in the under 30 and 40-49 age groups and negative in the other age groups. Using the 2006 migration probabilities resulted in a 62% increase in the number of nurses in 2022. It also substantially altered the age and sex structure of the workforce.

Together, these three migration scenarios show the sensitivity of the supply module to the values of and assumptions made about movements to and from the NT. Departures from past patterns are likely to have substantial implications for the long-term size and structure of the NT nursing workforce. Moreover, changes that affect the age structure will also impact on FTE nurse numbers with increases in younger age groups likely to increase FTEs and increases in middle (child rearing) and older age groups likely to decrease FTEs.

In 2006, Preston produced projections of the supply and demand for registered nurses in Australian states and territories including the NT.[4] As discussed previously, she used net separation rates to allow for attrition in the workforce and an increase of 1% was made to the NT rates to allow for higher turnover. Preston noted, however, that there was not strong evidence to support this alteration.[4] The alteration would have lead to the following annual net separation rates being applied in the NT projections:

Age Group	<25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60+
Rate	5.3%	5.4%	2.0%	1.5%	0.9%	2.2%	4.7%	8.9%	20.1%

Preston also allowed for overseas immigration of 36 nurses each year.[4] These separation rates and immigrant numbers (spread evenly over the 30-49 year age groups) were applied in the supply module of the nursing model along with projected graduate numbers. No other exits or entries (maternity, migration) were included. Based on Preston's assumptions, the projected number of nurses in the NT workforce in 2022 would be 2732. This estimate was 418 (13%) nurses less than the baseline projection and would be less than the growth in requirements.

The module used the national average for working hours and it was set the same for male and female nurses. NT rates by age and sex were derived from the responses to the 2007 NLF Census from nurses who worked only or mainly in the NT. The average hours were much higher than the national averages, but were consistent with differentials shown in past NLF publications. This tendency may not be unreasonable given the location and nature of remote area nursing and that most NT hospitals are located in small communities where part-time and casual staff may be difficult to obtain. The number of responses that these figures were based on was, however, only equivalent to about 40% of the workforce. Accordingly, the rates need to be considered with caution, particularly at an age and sex level as they could be subject to substantial bias. Use of the NT average working hours had a substantial impact on FTE supply, increasing it by 11% to a level where the FTEs supplied by the workforce were similar to the headcount number. Actual FTE nurse numbers increased by 8%, but were still 4% lower than the headcount number of nurses (3004 compared with 3124).

Gap analysis

Figure 6 shows the baseline demand and supply scenarios together. As can be seen, the growth in the supply of nurses was projected to be lower than the growth in requirements in the early years of the projection period. The gap widened to a shortfall of 71 nurses (3% of requirements) in 2010 then began to diminish as the increased flow of local graduates provided a steady boost to the workforce. From 2015 onward, the supply of nurses was projected to exceed demand and the gap continued to widen

over the remainder of the projection period. By 2022, there would be 275 more nurses than was needed to match growth in demand.

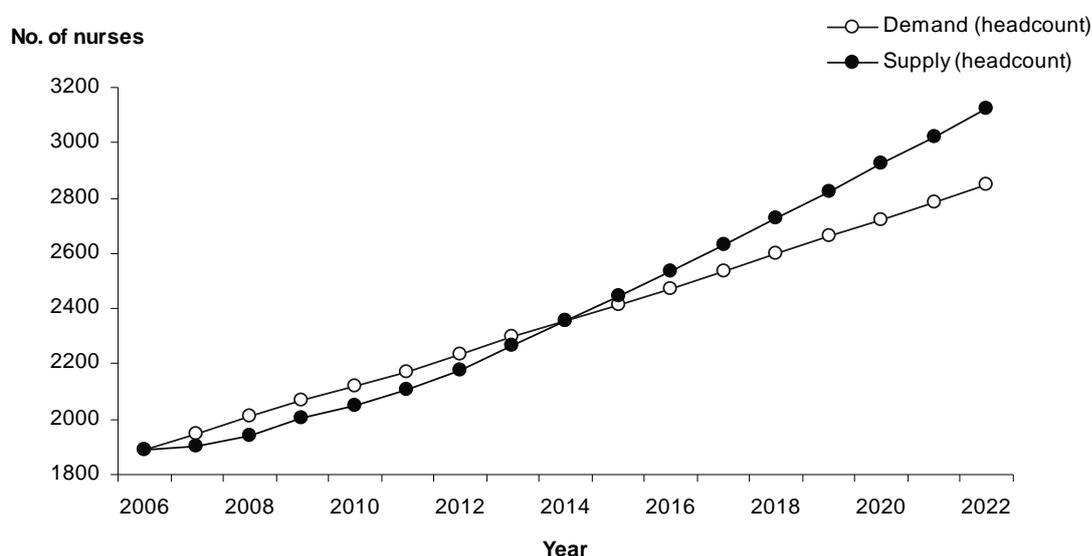**Figure 6 Demand for and supply of NT nurses, 2006 to 2022**

Figure 7 presents some alternative scenarios that emphasise key issues with the supply and demand of nurses in the NT. The trends approach indicated a much higher requirement for nurses than the needs approach. This approach reflected past expansion and was suggestive of the growth required to reduce the differential in health between Indigenous and non-Indigenous Territorians. The trends projection was similar to a supply projection that only allowed for exits and entries due to migration and maternity. This scenario would be possible if there were no other separations or nurses shifted to casual or part-time work rather than exiting completely and someone from that pool moved to full-time work. The latter is feasible since the NT appears to have a flexible pool of labour, which helps it manage periodic dips in staff that occur particularly in the wet season and the Christmas holiday period when many nurses leave the workforce temporarily or permanently to go interstate.[3]

Figure 7 also highlights two other key issues for the NT. A 10% decrease in immigrants showed the NT's susceptibility to changes in mobility patterns. Any reduction in immigration without a corresponding reduction in emigration is likely to impair the NT's ability to maintain a nursing workforce sufficient to meet health needs. This may well be the situation if shortages increase competition for nurses from other states and internationally. Although not specifically modelled, it would be reasonable to expect that the model is equally sensitive to changes in emigration. Decreases in emigration would enable greater growth in the workforce or reduce the need to attract interstate or overseas nurses. Conversely, increases in emigration would reduce growth and increase the need to recruit from interstate or overseas countries.

The other area of concern is transition pathways for graduate nurses. The number of local graduates should increase with the expansion of places in NT tertiary institutions, but if local employers are unwilling to take more graduates or prefer to take experienced nurses, it may be difficult for graduates to enter the workplace. Instead, they may choose other careers or move interstate. As the total workforce expands, it should improve the ability to absorb more graduates, but expansion will need to occur

soon with local graduates expected to exceed places on DHF's graduate nurse program in 2010.

Figure 7 Alternative scenarios of nursing demand and supply, 2006 to 2022
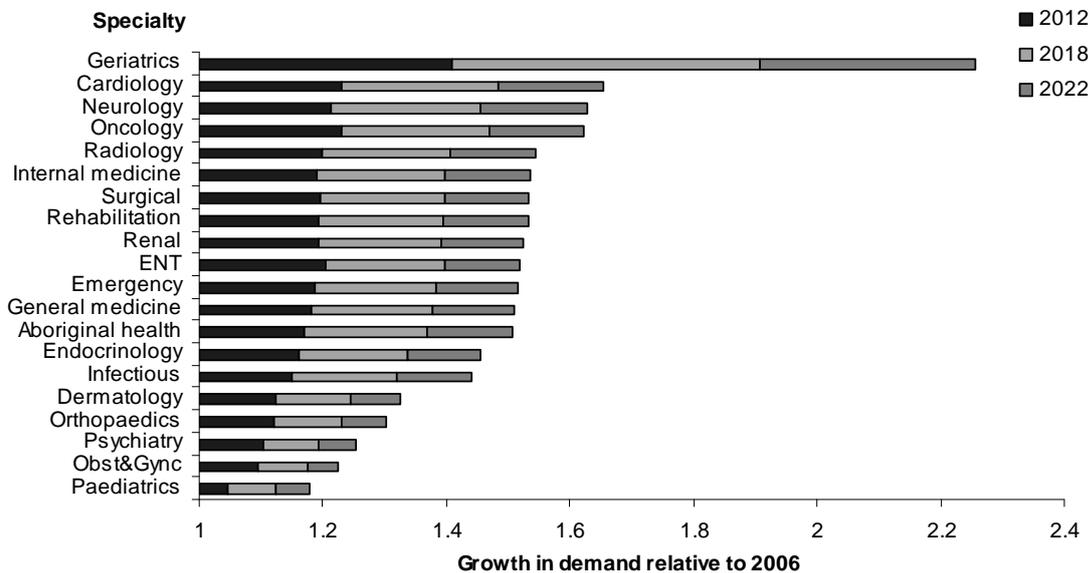
No. of nurses
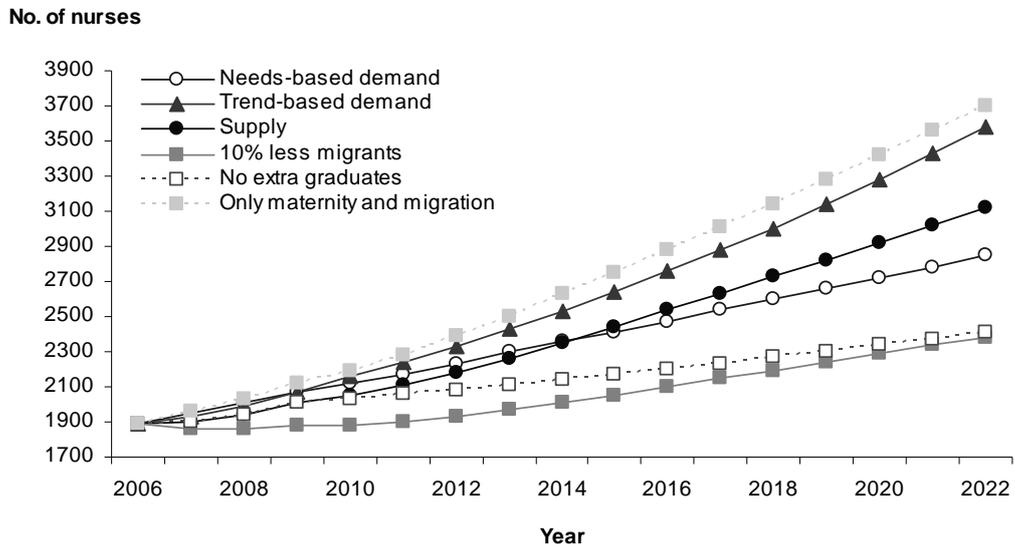
Other analyses

Nursing specialties

The projected demand for nursing services does not fall evenly across diseases or groups within the population. To examine the relative impact on different areas, 'Specialties' were identified by either the relevant population (Paediatrics – age 14 years and under; Geriatrics – age 65 years and over; Aboriginal Medicine) or allocation of BoD groups to a disease-based specialty based on the judgement of a health professional experienced in data analysis.

As shown in Figure 8, the greatest growth was expected to occur in servicing the needs of elderly people. Demand for nursing services from this group more than doubled over the projection period. Their major nursing service requirements were for COPD, heart disease, diabetes, dementia and lung cancer. Demand from Indigenous Territorians was expected to grow by 51% over the projection period. As with the elderly, heart disease, diabetes, COPD and lung cancer were key drivers of demand for Indigenous Territorians, but their other major requirement – stroke – differed. In terms of specific disease groups, the key pressure points for nursing services were the increase in demand for cardiology (66%), neurology (63%), oncology (62%), radiology (54%) internal medicine (54%) services.

Figure 8 Growth in nursing demand by specialty, selected years relative to base year of 2006

Note: 2006 is base year and not shown

ENT – Ear, nose and throat   Obst&Gync – Obstetrics and gynaecology

The supply of nurses to work in speciality areas was not projected due to the lack of a sound data source. The NLF census asks respondents to indicate their principal area of practice and one specialty area for their main and second job (recognising nurses may have several nursing jobs). The low response rate to the census means that many

nurses may not have been identified and estimates based on those who did respond may be biased.

Regional analysis

The NT needs to provide nursing services to a small population dispersed over a large geographic area. Presently, hospitals and other key health services (general practitioners, aged care services) tend to be located in the largest, most accessible population centres, namely, Alice Springs, Darwin, Katherine, Nhulunbuy and Tennant Creek. Beyond these main urban areas, nurses operate health clinics in small, remote communities complemented by visiting services from medical practitioners.[21] For future services, it is not only important to know the extent of growth, but where it is expected to occur (geographically) so that resources can be positioned appropriately.

Figure 9 shows a pressure point analysis by six regions based on statistical reporting areas. A map of the regions is at Appendix 1. The population forecasts by region were only available up to 2021 rather than 2022. Between 2006 and 2021, the greatest growth in the requirement for nursing services was expected from residents in Darwin, Palmerston and nearby settlements. Their nursing requirements were expected to be 60% higher in 2021 than in 2006. The next greatest increase (53%) was expected in East Arnhem. Growth was expected to be lowest in the Katherine region, but the requirement for nursing services from residents in this area were still expected to be 27% higher in 2021 than in 2006.

Figure 9 Growth in nursing demand by region, selected years relative to base year of 2006
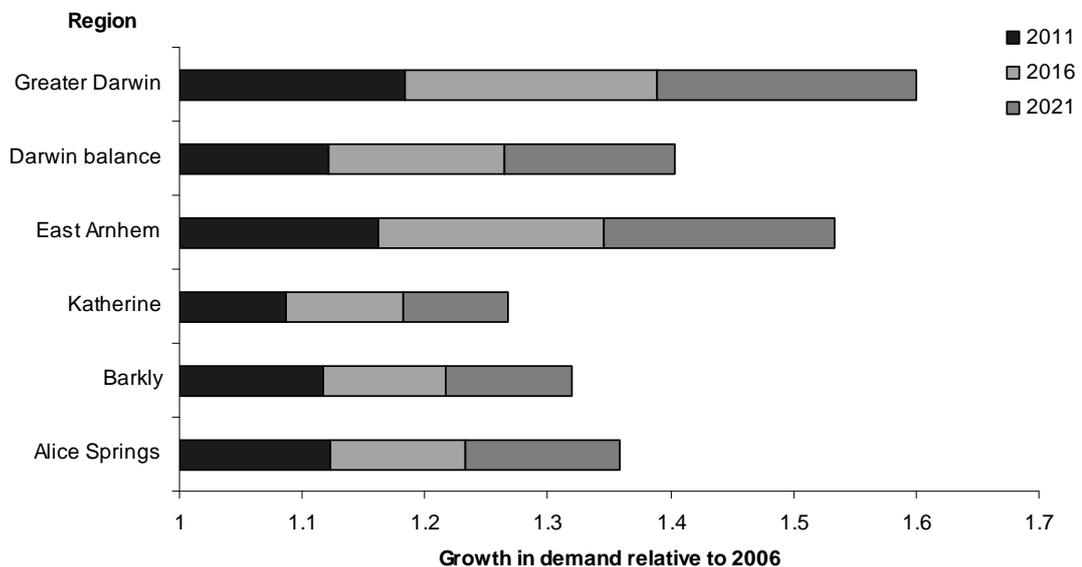
Note: 2006 is base year and not shown

Benchmark analysis

A key issue for the NT is the adequacy of the current number of nurses. To investigate this matter, the NT workforce was compared with the national average. The number of nurses per 1000 population was used as an indicator of availability and nurses per 100 disability adjusted life years was used as a measure of nursing professionals available to treat the amount of disease and injury in the population.

As shown in Table 10, the comparison revealed that the number of nurses per capita in the NT was 9% lower than the national average (9.0 per 1000 population compared with 9.8 nationally). The deficit worsened when considered in conjunction with the need for nursing services. The burden of disease in the NT was 1.5 times (50% more) than in the nation as a whole. When matched to the number of nurses, it meant that there were only 4.5 nurses for every 100 disability adjusted life year of illness or injury (DALYs) compared with 7.4 nurses nationally (39% fewer nurses).

Table 10 Comparison of national and NT nursing workforces by population and burden of disease, 2006

	Population	Nurses per 1000 population	Age standardised disability adjusted life-years (DALYs) per 1000 population	Nurses per 100 DALYs
NT	210,627	8.96	198.6	4.51
Australia	20,697,880	9.79	132.4	7.40

Sources:

ABS. Australian demographic statistics, June 2008. Cat. no. 3101.0, Table 4. Canberra: ABS, 2008.

AIHW. Health and community services labour force 2006, Table A4.6. Cat. no. HWL 43. Canberra: AIHW, 2009.

Begg S, Vos T, Barker B, Stevenson C, Stanley L, Lopez A. The burden of disease and injury in Australia 2003, Table 5.5. Cat. no. PHE 82. Canberra: AIHW, 2007

Nurses often provide health services in remote communities with only visiting services from medical practitioners so it would have been reasonable to expect a higher ratio of nurses in the NT. The shortfall is not made up by enrolled nurses as the NT also has fewer of these nurses (47%) although it does have 22% of the Aboriginal and Torres Strait Islander Health Worker (AHW) labour force. The deficit in medical practitioner numbers was similar to that for nurses (36%). Compared with the national average, the NT has 34% fewer nurses, doctors and AHWs available to treat every 100 DALYs in the population. Moreover, these ratios do not account for the additional demand associated with the high levels of comorbidity in Indigenous patients and the loss in efficiency associated with servicing small, remote communities such as time lost in travel, minimum staffing requirements, and extra staff to cover leave, professional development and other absences.

Although the NT has substantially fewer health professionals than might be expected, the national figures should be interpreted with caution as it is not clear that they represent efficient and effective health care. Rather, they could reflect over-servicing or historical legacies unrelated to the need for health services. The size of the gap does, however, show that the NT is an area of low supply where increasing the health workforce could generate greater benefits than might be achieved from their placement elsewhere in Australia.

Discussion

The baseline projections from the nursing model indicated that until 2015 there will be a shortfall in the number of nurses needed to meet the additional requirement for their services from a growing and ageing population. From 2015 onward, this circumstance will reverse and by 2022, there will be 275 more nurses than required to meet the projected increase in demand. In 2022, a total of 3124 nurses were projected to be in the NT workforce; an increase of 1236 (66%) from the workforce at the beginning of the projection period.

Even though NT workforce is expected to expand, it is still likely that Territorians will be disadvantaged relative to Australians as a whole in terms of access to nurses. In 2006, there were, on a per capita basis, far fewer nurses available to meet the health needs of the NT population than there were at a national level. To have the same number of nurses available to treat the burden of disease and injury in the NT population as available to met needs at a national level, the NT would have needed to have a workforce of 3095 nurses in 2006. That is, a workforce 64% larger than at present – a level similar to that projected to be achieved in 2022. If there was no change in the burden of disease and injury, 3919 nurses would be required in 2022 to be comparable to the national average. It is likely, however, that greater access to nursing services would reduce the burden of disease and injury so this would be a 'worst case' scenario in which no reduction in the health gap between Indigenous and non-Indigenous Territorians was achieved.

Even if the NT had the same burden of disease and injury as Australian as a whole then it would have still required 175 more nurses than it had in 2006 to provide comparable access. To be similar in 2022, it would require a total of 2612 nurses – 724 more than in 2006. The workforce mix in the NT tends, however, to be different with nurses providing health services in remote communities instead of medical practitioners (who may provide visiting services). This situation means that the NT should have more nurses per capita than the national average, although their number might be offset by AHWs who may substitute for nurses in the provision of some types of care. Regardless, when all these health professionals are considered, the NT still lags far behind Australia in the numbers it requires to provide comparable access to its population and improve the population's health. In 2006, there were only 6.8 health professionals[a] to attend to every 100 DALYs in the NT compared with 10.2 nationally.[1,22]

In addition to increasing the overall size of the nursing workforce, it will be important to ensure that extra nurses are located where they are most needed. The regional analysis showed that the greatest increase in the requirement for nurses will be the Darwin region and it may be relatively easy to attract them to work there. The next area of greatest need was East Arnhem, but expanding the nursing workforce there may be more challenging. Recruiting nurses with the appropriate aptitude for work in remote areas may not be easy and new recruits tend to require substantial training and support.[3] After recruitment, it can be even more challenging to retain nurses in remote areas and small regional hospitals as many move on after a relatively short period of time to find less stressful work or less isolated locations.[3]

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[a] Medical practitioners, registered nurses, enrolled nurses, AHWs.

DHF is the primary employer of nurses in the NT so much of the growth in the workforce would need to come from expansion in its workforce. Such expansion would need to be supported by an increase in DHF's budget. If all additional nurses were employed by DHF, it would require additional funding of more than $90 million (2006-07 prices) in 2022.[23] While this is a sizeable amount of additional funding, it represents less than 10% of DHF's current budget, which has grown by 117% since 2001.[24]

The availability of funding will be an important factor influencing the growth in the NT nursing workforce. A further issue will be the ability to secure a sufficient number of nurses. In each year, between 10% and 30% of nurses in each age group are expected to leave the NT and between 9% and 39% were expected to arrive in the NT. Any reduction in immigration or increase in emigration could have a substantial impact on growth. The NT has to compete with other states and countries for nurses and if shortages in other places increase competition, the NT may find it difficult to replace departing nurses and acquire extra nurses. Moreover, as the workforce expands so to will size of this recruitment task unless turnover rates are reduced.

More generally, the model was found to be extremely sensitive to changes in migration rates. In part, this was due to the manner in which migration was modelled. Probabilities were used, that is, emigration was set as the proportion of the previous year's workforce that would leave and immigration was set as the proportion of the current year's workforce that arrived during the year. This approach meant that the number of nurses migrating varied depending on the size of the workforce (numbers were not fixed). Migration rates also differed by age group so it affected the age structure of the workforce with flow-on implications for maternity and retirement exits. Together, these effects mean that small changes could have a large impact on results. The change in the migration rates revealed this variable's importance and its impact on ageing. It also reinforced the importance of retention to stabilise and grow the workforce.

A more stable workforce could also have other benefits. The departure of nurses is particularly costly not only in terms of recruitment costs, but also the effect on productivity. In 2006-07, turnover was estimated to have cost DHF at least $6.9 million.[3] Particularly costly was the loss in productivity from newly hired nurses and the effect on remaining nurses whose workload may increase as they take on extra tasks and responsibilities, train new employees and increase the time spent on recruitment to temporarily and permanently fill vacated positions.[3] The supply module made no allowance for changes in these productivity effects, but should turnover diminish, fewer nurses may be needed to meet the growth in health needs if current levels of turnover are reducing the productivity of the workforce.

An important inflow to the nursing workforce will be graduate nurses and the number of local graduates from NT tertiary institutions is expected to increase substantially in coming years. The usual transition path into the workforce for these nurses is DHF's graduate nurse program. If, however, their number exceed the places available on the program then it may be difficult for nurses to move from university study to the workplace. Although experienced nurses may be more useful in the challenging nursing environment of the NT, local graduates may be more likely to stay and stabilise the workforce. They also tend to be younger and will have longer to contribute than experienced, but older migrant nurses. Thus, it will be important to ensure that pathways between study and the workplace expand in line with the likely number of local graduates to facilitate their successful entry and retention in the NT workforce.

Estimating the shortfall in nurses and thus, the required number of graduate nurses has been a focus of the National Health Workforce Taskforce's national modelling and

Preston's work in 2006.[4,5] Both have shown the NT to have a shortfall of nurses and to need additional graduates for supply to meet demand. These models allowed for a shortage of nurses at the start of the modelling period. The NT model did not make an allowance for a shortage and instead conducted a benchmark comparison to indicate to adequacy of the current workforce. Inclusion of a shortfall would have increased demand (and therefore the gap between demand and supply) by a constant amount across the projection period. Caution is needed, however, in applying an estimate of a 'shortage' as lower numbers might be a reflection of budget or other constraints (including funds available for recruitment, relocation and training) rather than an inability to obtain nurses.

Previous models also differed from the NT nursing model in their approach to estimating demand. The national model applied a constant annual increase of 4% based on population growth with weightings for Indigenous status and the elderly.[5] Preston applied a population age profile factor of between 2% and 4%.[4] The factor was based on age related usage of nursing services in hospitals, aged care homes and other health and non-health setting that require registered nurses.[4] In contrast, the needs approach of the NT model produced an annual growth rate of 3% at the beginning of the projection period, which then declined over the projection period to 2% in the final year. This growth implicitly assumed that the burden of disease remained the same, which may not be desirable. The trends approach produced growth rates more akin to the other models and may better represent the growth needed to reduce the health gap between Indigenous and non-Indigenous Territorians and the differential between national and NT levels of access to nurses.

In terms of supply, the national model set inward and outward migration at the same rate so there was no growth from this source. It also allowed for retirements and exits for other factors. Attrition in Preston's model was based on net separations, which were determined from the change in the proportion of people with a nursing qualification that were still in the workforce between different ages. Migration was allowed for with a fixed intake of overseas nurses. The NT nursing model is likely to better account for the impact of interstate and international immigration and emigration than these models; however, it may have understated exits and re-entries due to study, ill-health, career change and other reasons. Preston indicated that these may be quite substantial, particularly in the early years as nurses decide they do not like the nature of the work.[4] DHF data on exits was limited to those who completed exit interviews and it could not be determined whether exits were temporary or permanent or a transition from DHF to another health provider (no loss to the workforce). Furthermore, losses may only be temporary if exiting nurses can be replaced through migration. Further research is recommended to clarify the extent and nature of these movements and determine whether migration offsets these losses.

In addition to the issues raised above, the NT model has some other limitations. These are:

- the quality of the data for the supply module – better data on the existing NT nursing workforce including their number, age (by single years) working hours, exits and re-entries due to factors other than migration could improve the modelling;

- the use of hospital data to determine nursing workforce requirements – this sector may not be representative of requirements in other sectors; and

- the model does not account for the impact of fiscal, policy, infrastructure or other constraints.

These are issues common to both the nursing and medical models and are discussed more fully in the Medical Model Report. Improving the response rate to the NLF census may improve data for various variables the nursing model's supply module. For the graduate component of the supply module, it would be beneficial to collect demographic data on graduate nurses to compare with student profiles. For the demand module, further research is needed on nursing weights for other sectors such as aged care and primary care. Finally, the presence of fiscal and other constraints means that the projections from the model should be interpreted in conjunction with these limitations where they can be identified and quantified.

Conclusion

The projections from the NT Nursing Workforce Model indicated that growth in the supply of nurses over the period 2006 to 2022 would, after an initial shortfall, exceed the growth in requirements for their services. The result was, however, particularly sensitive to trends in interstate and international migration. It would also be dependent on funding being available to support the growth in numbers and for there to be effective transition pathways between study and the workplace for the expected increase in local graduates. Should the projected increase in supply occur, there would be a greater number of nurses available to address the burden of disease and injury in the NT and the number of services provided per capita could be increased. Such an increase could improve access to services, particularly for Indigenous Territorians who bear the greatest burden of ill health.

The results from the NT were more positive than past models, which showed a greater gap between demand and supply. This difference could be attributable to the NT model's needs based approach, which assumed a continuation of the current burden of disease and injury and resulted in lower growth in demand than in past models. A trends approach provided an alternative estimate that projected a continuation in the expansion of services and would be likely to reduce ill-health in the population. Exits from the nursing workforce were conservatively modelled and the interaction between these and migration needs further investigation to clarify their actual impact on the NT nursing workforce. The nursing model better accounted for immigration to and emigration from the NT than previous models.

The model identified key pressure points in demand. These pressure points included the needs of elderly patients, which were expected to more than double and substantial growth in the specialty areas of cardiology, neurology and oncology. From a regional perspective, Darwin was expected to experience the strongest growth in the demand for nursing services, followed by East Arnhem.

An important issue for the NT will be the migration patterns of nurses. The NT has been good at attracting nurses, but emigration rates are also high. This turnover is costly in terms of recruitment expenses, training and lost productivity. Minimising emigration would increase the stability of the workforce, reduce the cost of turnover and allow the NT to more readily expand its nursing workforce.

An expected increase in the flow of local nursing graduates in coming years provides an opportunity for the NT to expand its workforce and increase stability. At present, local graduate numbers are insufficient to fill places on DHF's nursing graduate program. In future years this situation may reverse and pathways into the workforce may need to be expanded to ensure that graduate nurses can transition easily from study to work. In addition to an increased likelihood of staying in the NT, local graduates also offer the benefit of their relative youth, which means that they have many years of potential contribution in the workforce, and they will be more aware of the NT's unique environment than interstate and overseas nurses.

Appendix 1 NT Government statistical regions

Figure 10 NT Government statistical regions
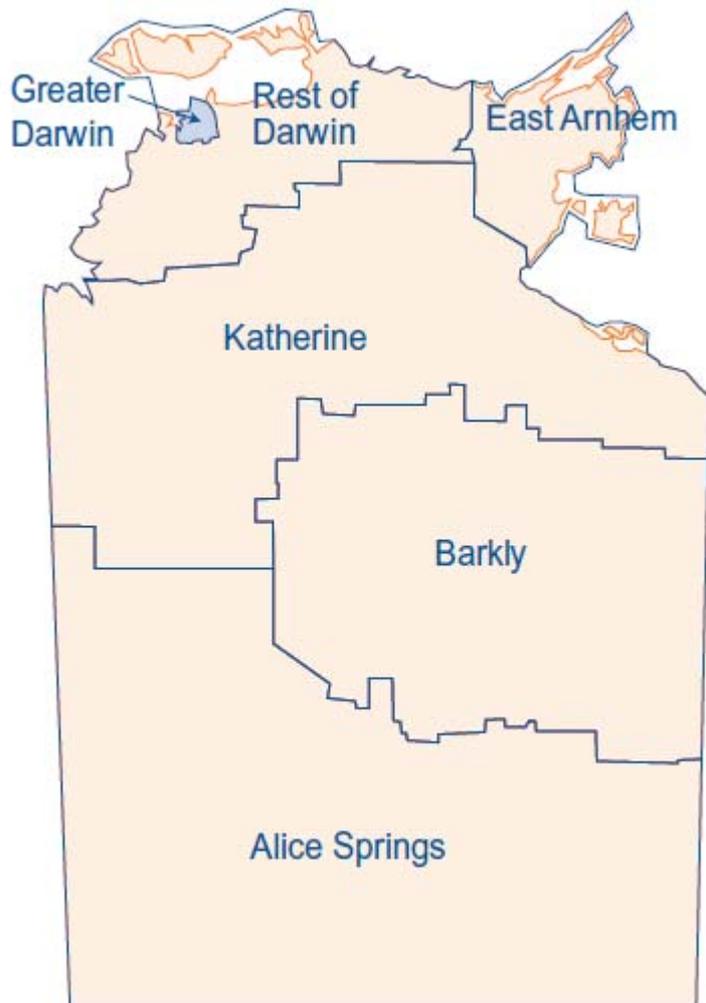
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