Medical staffing in Ontario neonatal intensive care units

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Advances in technology have improved the survival rates of infants of low birth weight. Increasing service commitments together with cutbacks in Canadian training positions have caused concerns about medical staffing in neonatal intensive care units (NICUs) in Ontario. To determine whether an imbalance exists between the supply of medical personnel and the demand for health care services, in July 1985 we surveyed the medical directors, head nurses and staff physicians of nine tertiary level NICUs and the directors of five postgraduate pediatric residency programs. On the basis of current guidelines recommending an ideal neonatologist:patient ratio of 1:6 (assuming an adequate number of support personnel) most of the NICUs were understaffed. Concern about the heavy work pattern and resulting lifestyle implications has made Canadian graduates reluctant to enter this subspecialty. We propose strategies to correct staffing shortages in the context of rapidly increasing workloads resulting from a continuing cutback of pediatric residency positions and restrictions on immigration of foreign trainees.

Les progrès dans les techniques en périnatologie ont permis d'améliorer les taux de survie des nouveau-nés de faible poids. Vu l'augmentation des soins qu'ils exigent et la diminution du nombre de postes de formation au Canada, on se demande avec inquiétude s'il y a suffisamment de spécialistes dans les pouponnières de soins intensifs (PSI) en Ontario par rapport aux besoins. Afin de répondre à cette question, nous avons sondé en juillet 1985 les médecins-chefs, infirmières-chefs et médecins traitants de neuf PSI de niveau tertiaire et les directeurs de cinq programmes de formation postdoctorale en pédiatrie. Si on se fonde sur la norme reconnue actuellement, soit un néonatologue pour six malades (pourvu que le personnel de soutien soit suffisant), la plupart des PSI n'en ont pas assez. Les nouveaux diplômés au Canada sont peu enclins à embrasser cette sous-spécialité, craignant la somme excessive de travail qu'elle comporte et la répercussion de celle-ci sur leur mode de vie. Nous proposons un plan d'attaque afin de pourvoir les postes vacants devant l'augmentation rapide des tâches individuelles amenée par la diminution constante du nombre de postes de résidence en pédiatrie et la restriction de l'immigration de médecins formés à l'étranger.

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Regionalization of perinatal care[1] together with advances in technologic expertise and therapeutic interventions have increased the survival rates for infants of extremely low birth weight.[2] To reduce the incidence of neurologic and functional impairment, newer diagnostic and monitoring techniques coupled with therapeutic interventions have been implemented in neonatal intensive care units (NICUs).[3] Increasingly complex equipment and improved treatment of pathophysiologic states have increased the workload of caregivers within NICUs.

A multidisciplinary research group at McMaster University, Hamilton, Ont., conducted a descriptive study to evaluate the factors affecting the supply of medical personnel and the demand for health care services in Ontario NICUs for the period 1980–84. The primary aim of the study was to determine whether an imbalance exists between workload and the supply of medical personnel in Ontario level III NICUs. A level III NICU is

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defined as a central referral unit for high-risk perinatal problems whose assessment and management require more specialized professional expertise.[4]

Methods

In this study supply was defined as quantitative consideration of the numbers and distribution of facilities and health care personnel relative to the population served.[5] To assess supply we studied the factors listed in Table I.

In July 1985 we surveyed the medical directors of all 10 level III NICUs in Ontario for annual data for 1980–84 on numbers of neonatologists, pediatricians, neonatology trainees and pediatric residents staffing their units, the percentage of time that each staff member spent in direct patient care, education, research and administration, and the number of neonatology trainees and pediatric residents staffing each shift on weekdays, weeknights and weekends. The definition of a neonatology trainee for the purposes of this study was a pediatric resident specifically training in the care of the newborn.

We surveyed the directors of all five Ontario postgraduate pediatric residency programs for annual data for the same period on the number of neonatology trainee and pediatric residency positions filled by Canadians and by non-Canadians and the number of graduates from the subspecialty programs in neonatology.

We surveyed all 80 physicians working in the 10 level III NICUs at the time. Physicians included neonatologists, neonatology trainees and second-year to fourth-year residents in the core pediatric programs. Information collected from the physicians included number of years of experience in an NICU, size of daily patient assignments and amount of time spent in direct patient care, education, research and administration.

In this study, demand was defined as the type and amount of health care services required.[5] Since the type and amount of health care services provided in an NICU vary with patient acuity, we studied the factors listed in Table II. Each of these factors permitted assessment of change in patient acuity over the study period. Patient acuity is defined as the number of direct hours of actual "hands-on" patient care and is categorized as convalescent, intermediate or intensive,[6] increasing acuity being associated with more intensive care.

All 10 NICU medical directors and head nurses were asked to provide annual data for 1980–84 about demand, including number of admissions to the NICU according to birth weight, length of stay, ventilator patient-days, patient acuity, rates of transfer out of the NICU and occupancy rates.

All the questionnaires were self-administered. To increase the response rate we mailed to the nonrespondents a second set of questionnaires; if these were not returned the nonrespondents received a telephone reminder.

Adequacy of staffing in NICUs has previously been determined by calculating the ratio of personnel to patients.[6,7] To determine the balance between supply and demand we calculated the clinical workload for neonatologists by dividing the official bed capacity for each NICU by the number of neonatologists staffing the unit.

Comparable data are presented from all centres when available. When uniform data for all the years surveyed were not available from other units, the data from the NICU in the McMaster Division of Chedoke–McMaster Hospitals were used to illustrate trends.

Results

One of the 10 NICUs surveyed was designated as a level II NICU by its medical director and was therefore excluded from the analyses. The response rates for the remaining nine NICUs were 89% (8/9) for medical directors, 100% (5/5) for program directors and 71% (57/80) for physicians. Data about demand were provided by the medical

Table I — Factors affecting the supply of medical personnel in level III neonatal intensive care units (NICUs) in Ontario

Factor	Rationale for inclusion
Time spent by neonatologists, neonatology trainees and pediatric residents in direct patient care/education/research/administration	To determine amount of time spent in direct patient care by NICU physicians
Staffing ratios in NICUs per shift	To compare with "ideal" ratios
No. of neonatology trainees graduating to practise in Canada	To determine whether there are enough physicians being trained to practise as neonatologists in Canada

Table II — Factors affecting the demand on medical personnel in NICUs

Factor	Rationale for inclusion
Admissions to NICU, by birth weight	To assess change in patient population
Length of stay in NICU, by birth weight (patient-days)	To assess change in patient acuity
Ventilator patient-days	To assess change in patient acuity
Rates of transfer out of NICU	To assess whether more infants are transferred out for convalescent care to make room for more critically ill infants
Occupancy rates	To assess effect on workload

directors and head nurses for 78% (7/9) of the NICUs.

Factors affecting the supply of personnel

Fig. 1 summarizes the percentage of time spent by neonatologists, neonatology trainees and pediatric residents in direct patient care, education, research and administration in 1982–84 as reported by the NICU medical directors. Neonatologists spent an average of 39% (19 to 39 hours) of their average 64-hour workweek in direct patient care, and neonatology trainees spent an average of 55% (27 to 41 hours) of their time in this activity. For both these groups there was a wide range of responses, the time spent in patient care ranging from 15% to 80%. In contrast, pediatric residents spent 70% to 90% (average 84%) of their time in direct patient care. Responses from the staff physicians confirmed these figures.

The ratio of neonatologists to patients in the eight NICUs in 1984 ranged from 1:6 to 1:12. To determine the adequacy of the number of neonatology trainees and residents staffing the NICUs, we compared the ratio of these personnel to patients on weekdays, weeknights and weekends. In 1984 each neonatology trainee or pediatric resident was responsible for an average of 11 patients (extremes 6 and 20) on weekdays. On weekday nights and weekends this increased to an average of 19 patients (extremes 8 and 30).

Positions filled by Canadian and non-Canadian neonatology trainees in the eight NICUs were compared. Except in 1984, neonatology trainee positions filled by non-Canadians outnumbered positions filled by Canadians, in ratios ranging from 2:1 to 6:1 (Table III). These figures do not represent the total number of trainees staffing Ontario NICUs because some hospitals are able to fund additional positions through private (internal) resources. Between 1980 and 1984 there were approximately 10 such positions in 4 hospitals, 70% of which were filled by non-Canadians. The number of non-Canadian graduates from these programs over the 5 years, 66, substantially exceeds the number of Canadian graduates (10). Of the 66 non-Canadian graduates 16 (24%) remained in Canada to practise neonatology on completion of their training, compared with 9 (90%) of the Canadian graduates.

Factors affecting the demand on personnel

The number of infants of extremely low birth

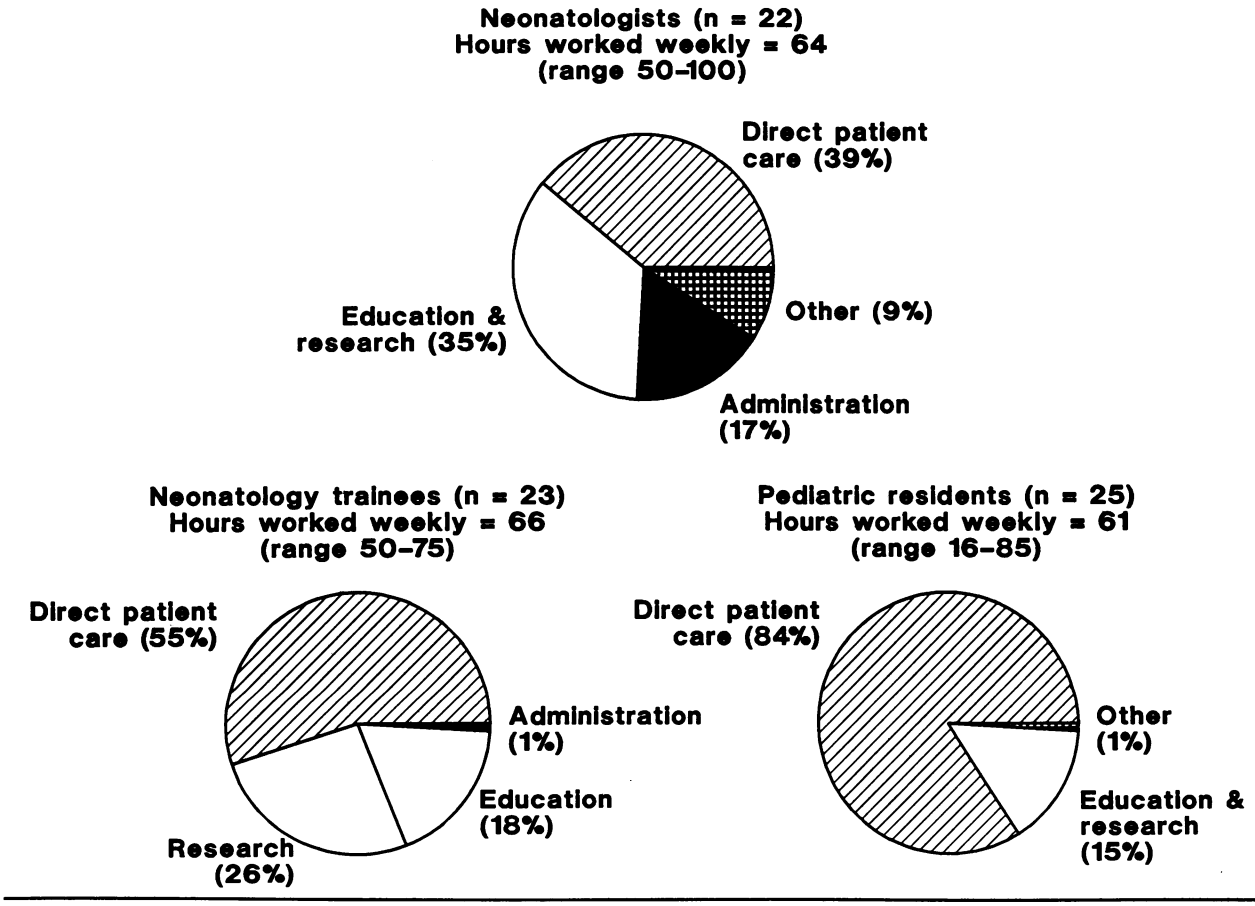

Fig. 1 — Percentage of time spent in various activities by neonatologists, neonatology trainees and pediatric residents in level III neonatal intensive care units (NICUs) in Ontario in 1982–84, as reported by medical directors.

weight (less than 1000 g) admitted to the McMaster NICU in 1984 was 30% higher than the number admitted in 1980. In the same unit the number of infants admitted weighing 1000 g or more increased by only 2%. Between 1982 and 1984 the number of infants weighing less than 1000 g admitted to an NICU in London, Ont., increased by 58%, whereas the number of those weighing 1000 g or more decreased by 2%. Similar trends were observed in other Ontario NICUs, but complete data were unavailable for analysis.

Owing to their small size and more critical health status, babies of extremely low birth weight remain in NICUs longer.[8] In 1984 the average length of stay in the McMaster NICU for infants weighing 1000 g or more was 11.7 days, compared with 40.7 days for infants weighing less than 1000 g. The corresponding figures for an NICU in London in the same year were 12.6 and 53 days.

In five NICUs for which comparable data were available, the total number of patient-days increased by 23.3%, from 28 289 in 1981 to 34 868 in 1984. Increasing lengths of stay contributed to the increasing number of patient-days between 1981 and 1984.

Low-birth-weight infants often require assisted ventilation, which necessitates intensive surveillance and care by clinicians. This correspondingly raises the level of patient acuity. At an NICU in London the total number of ventilator patient-days rose from 745 in 1981 to 2500 in 1984, an increase of 235.6%. During the same period, in the largest level III NICU in Ontario the total number of ventilator patient-days increased 105.1%, from 3251 to 6669.

Fig. 2 shows the percentage increase between 1980 and 1984 in the admission and occupancy rates, patient-days, patient acuity and transfers out of the NICU at McMaster. The rate of transfer of patients out of the NICU increased substantially in the face of relatively stable admission and occupancy rates. This is the result of increasing patient acuity, which is reflected in the increased number of patient-days; this suggests that the smaller infants whose condition was more critical remained in the NICU longer.

At McMaster, where there have been no apparent changes in the birth rate or referral pattern since 1977,[9] there was a 10-fold increase between 1977–80 and 1981–84 in the number of infants weighing 501 to 600 g at birth who survived.[9]

The length of stay affects occupancy rates, which climbed during some months to greater than 100% at some of the NICUs. At McMaster the occupancy rate exceeded 100% during 2 months in 1982, 3 months in 1983 and 5 months in 1984. Occupancy rates greater than 100% far exceed the Canadian hospital standards for nurseries, 65% to 70%.[10]

Discussion

In 1980 the Committee on Fetus and Newborn of the American Academy of Pediatrics recommended that level III NICUs be staffed by at least three full-time neonatologists to provide patient care while meeting educational, research, investigational and administrative needs.[11] In 1985 the committee recommended that neonatologists supervising an adequate number of other health care providers, such as additional physicians or nurse-clinicians, should each care for an average of six patients.[7] On the basis of this recommendation, between 1980 and 1984 the total number of neonatologists required to staff seven Ontario

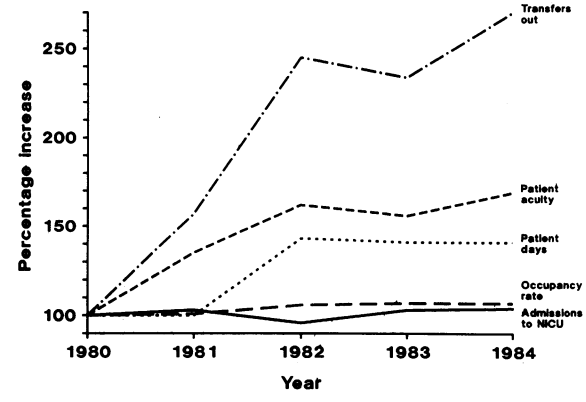

Fig. 2 — Percentage increase in factors affecting demand on medical personnel between 1980 and 1984 at NICU in McMaster Division of Chedoke-McMaster Hospitals. To permit comparison of five different measurement units all data originate at the 100% point.

Table III — Number of neonatology trainee positions funded by the Ontario Ministry of Health filled by Canadians and non-Canadians in Ontario in 1980–84

Year	No. of positions (and extremes*)			Ratio of non-Canadians to Canadians
	Canadian	Non-Canadian	Total	
1980	3 (0, 1)	10 (0, 6)	13 (0, 6)	3:1
1981	3 (0, 2)	11 (1, 6)	14 (1, 6)	4:1
1982	2 (0, 1)	11 (0, 6)	13 (0, 6)	6:1
1983	5 (0, 2)	10 (0, 5)	15 (0, 6)	2:1
1984	7 (0, 2)	9 (0, 4)	16 (1, 6)	1:1

*Variation in the number of positions reported for individual NICUs.

NICUs was 25. The average actual staff complement was 18, a shortfall of 28% (Table IV).

Fig. 3 shows the supply of neonatologists per NICU from 1982 to 1984 relative to the product of bed capacity and occupancy rate (factored capacity). Although bed capacity is an officially stated number for each unit, several units were forced to exceed bed capacity during this period to respond to the province's need for neonatal intensive care. The factored capacity, therefore, gives a more accurate representation of the situation. With current guidelines specifying an ideal neonatologist: patient ratio of 1:6, given an adequate number of support staff,[7,11] most of the NICUs would be considered to be understaffed even if the necessary infrastructure were present. In fact, the report of the Sub-Committee on Institutional Program Guidelines for Canada suggests that when the infrastructure of personnel in NICUs is absent, the ratio of one neonatal or perinatal specialist to six patients should be increased.[6] Moreover, the recommended ratio, which evolved from a report by Swyer,[12] is now 19 years out of date, and new standards are urgently needed given the rapidly changing levels of acuity in Ontario NICUs.

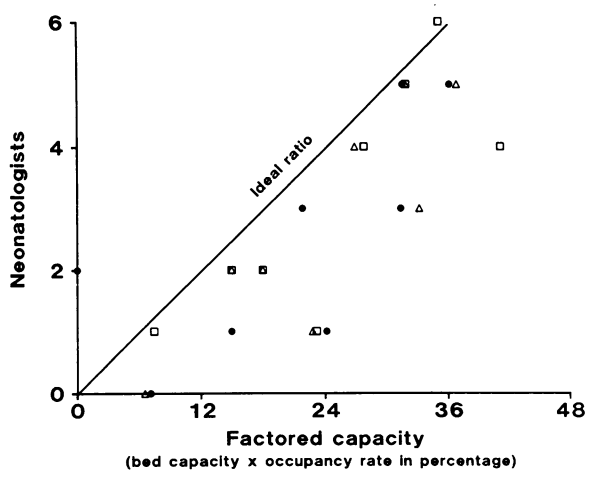

Fig. 3 — Supply of neonatologists per NICU relative to bed capacity and occupancy rate. Ideal ratio is that recommended by the American Academy of Pediatrics.[7] ● = 1982; Δ = 1983; □ = 1984.

Although the amount of time that neonatologists and neonatology trainees spent in direct patient care varied considerably across the nine NICUs, pediatric residents consistently spent 84% of a 61-hour workweek (51 hours) in this activity. This heavy clinical load is felt to compromise the educational objectives of residents. The Royal College of Physicians and Surgeons of Canada now emphasizes structured educational activities, integrated program activity, ambulatory care experience and opportunities for scholarship and research in their objectives for specialty trainees.[13] This emphasis challenges all residency programs to broaden educational components for residents while ensuring that the clinical teaching units in which training occurs continue to provide optimal patient care and meet all service needs.[13]

The number of patients assigned to each neonatology trainee or pediatric resident in Ontario NICUs is excessive given the critical condition of these infants. In our study many of the trainees and residents were caring for up to 11 patients on weekdays and up to 19 on weeknights and weekends. A large increase in the workload at night may not be justified, because critically ill neonates do not show the typical wakefulness–sleep patterns of patients in an adult or pediatric ward. Other than activities such as patient rounds and elective investigations, the three shifts in an NICU are very similar in terms of service demands such as numbers of admissions and numbers of infants needing intensive surveillance.

Although enough Canadian physicians are applying for pediatric residency positions, they are much less interested in becoming subspecialists in neonatology, as is evidenced by the paucity of Canadians in neonatology trainee positions in our study. Consequently, there is a heavy reliance on non-Canadians to fill these positions. In the past, most of these physicians have chosen not to remain in Canada as neonatologists. Recent government legislation and inhibitory professional screening requirements have greatly reduced the number of non-Canadian applicants to neonatology trainee positions while prohibiting even those few who are interested in remaining, and who are needed to fill vacant positions, from doing so.

Table IV — Ideal and average actual staff complement in seven level III NICUs in Ontario in 1980–84

NICU no.	Mean no. of patient-days per annum	Ideal complement[7]	Actual complement*
1†	13 588	6.2	4.8
2	10 131	4.6	5.0
3	9 796	4.4	3.7
4	8 641	4.0	1.0
5	4 696	2.1	1.5
6	4 643	2.1	2.0
7	2 934	1.3	0.5
Total	54 431	24.9	18.2

*Total number of neonatologists in 1980-84 divided by the number of years.
†Data available only for 1982–84.

The nature of neonatal care has changed in recent years. Whereas NICU beds were once filled with infants ranging in health from critically ill to convalescent, the convalescent infants are now being transferred to other units, so that the NICU has a higher proportion of infants of very low birth weight who are critically ill and who need intensive surveillance. This change in the nature of the NICU patient population has caused an increase in both the workload and the stress level of clinicians. Concomitant with this development the Ontario government has legislated two changes that affect the medical staffing of NICUs. First, non-Canadian physicians who come to Canada for specialty training are not allowed to remain in the country after completion of their training. This has a significant effect in neonatology because many of the neonatology trainee positions are filled by non-Canadians. Second, the government has ordered a cutback of 35% in the funding of pediatric residency positions, to occur over a 5-year period.[14] This cutback has already worsened the personnel shortage in Ontario NICUs. This disequilibrium will become even more dramatic owing to the recent change in guidelines recommending that bed requirements for NICUs per 1000 births be increased to 1.75 from 1.00.[15] This requirement was calculated on the basis of survival rates and duration of hospital stay, the three recognized levels of care needed for the sick neonate being taken into account. NICUs will therefore have more beds filled with critically ill infants but fewer physicians to provide the intensive care required.

We have shown that there is a disequilibrium in the medical staffing of Ontario NICUs, with demand exceeding supply. Strategies to address this medical staffing shortage must be considered. Although additional neonatologists are needed, the main requirement is for bedside caregivers. As neonatologists spend only 39% of their time in actual caregiving, increasing their numbers to resolve the service shortfall would be inefficient. Increasing the percentage of time neonatologists spend in patient care would compromise their leadership activities in education, research and administration.[11] Moreover, there is a very small pool of Canadian neonatology trainees from which to draw. Increasing the number of trainees is not a feasible alternative given that recruitment to date of both Canadian and non-Canadian applicants has been difficult.

What is needed is replacement of resident-dependent activity with resident-independent service. The existing shortfall may be met by other alternatives, including "complement" and "substitute" personnel such as general pediatricians, general physicians, anesthetists, respiratory therapists and expanded-role nurses or some optimal combination of these professionals (Jonathan Lomas: unpublished data, 1987). The roles of health care workers such as nutritionists, pharmacists and biotechnologists in direct patient care should be explored further. It is important that the alternatives selected be evaluated as to availability, feasibility, acceptability and cost-effectiveness.

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