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ABSTRACT

The Committee of the Ontario Council of Deans of Medicine was designed and directed to examine the production of specialized manpower from training programs sponsored by Faculties of Medicine of the Ontario universities and the nature and extent of medical research in the Faculties of Medicine. The inquiry was concerned with both the current situation and future plans and projections. The purpose of this survey was to establish an information base upon which Medical Faculties individually or in collaboration might develop their own plans within an overall framework that would insure the most effective use of the Provincial resources available, minimize duplication and protect against the possibility of neglect through oversight of important areas of research and development. (Author/HS)

SPECIALIZED MANPOWER PRODUCTION AND RESEARCH DEVELOPMENT

IN ONTARIO FACULTIES OF MEDICINE

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SPECIALIZED MANPOWER PRODUCTION AND RESEARCH DEVELOPMENT

IN ONTARIO FACULTIES OF MEDICINE

SECTION I: INTRODUCTION

In April 1969, a Committee of the Ontario Council of Deans of Medicine was established with representation from the Faculties of Medicine of the University of Ottawa, University of Toronto, University of Western Ontario, Queen's University and McMaster University. The Committee was directed to examine the production of specialized manpower from training programmes sponsored by Faculties of Medicine and the nature and extent of medical research in the Faculties of Medicine. The enquiry was concerned with both the current situation and future plans and projections.

The purpose of this survey was to establish an information base upon which Medical Faculties individually or in collaboration might develop their own plans within an overall framework that would ensure the most effective use of the Provincial resources available, minimize duplication and protect against the possibility of neglect through oversight of important areas of research development.

In order to obtain up-to-date information, a survey questionnaire was devised and information collected through the Committee representatives at each of the five Faculties of Medicine. In the survey, research was reviewed by field of research (not departmental) whereas manpower training was basically according to academic department. The definitions used for the survey and some of the limitations of the questionnaire are described in the appropriate sections of the report. It was agreed that the time interval to be studied should have a minimum retrospective component and should concentrate on the current status and projections to 1974-75. The retrospective component was considered valuable chiefly in relation to manpower data to permit comparison with earlier surveys. The Committee was impressed with the effort made in each Medical School to provide the necessary information but was also aware of the unavoidable subjectivity of response to many of the questions.

The definition of what constitutes medical research was discussed at length by the Committee and it was agreed that in addition to basic and applied research, developmental and operational research on health care and hospital services should be included. It was recognized that a good deal of research relevant to medicine is carried out in Faculties of Engineering and departments of biological, behavioural and social sciences and that this may have been missed because the survey was directed only to Faculties of Medicine. It was considered desirable to extend this study subsequently to other health disciplines. Enquiries were directed to certain institutes and foundations which operate outside the universities' sphere of influence but for the most part the response was unsatisfactory or incomplete.

The Committee met on six occasions between April 1969 and May 1970. Its report has been prepared for the purpose of making available information on the current and projected state of research development and medical manpower training. Interpretation has been limited to conclusions derived from the data. No attempt has been made to use the data to develop policy recommendations.

II AN INVENTORY OF RESEARCH PROJECTS AND THEIR FINANCIAL SUPPORT

The present study was undertaken with a view to determining the nature and amount of research carried out in the Medical Schools of Ontario in 1969. As a secondary objective some information about costs and the extent of duplication of projects has been sought.

Data has been supplied by each of the schools concerning the principal investigators and the extent of support received on an annual basis. Data were collected between June and September 1969. Information concerning support staff was incomplete and accordingly has been excluded.

METHODS

In order to analyse the data received certain general principles had to be established. In the first instance, a classification of work proceeding had to be developed. This classification is neither comprehensive nor ideal but is one which allows treatment of data of the type available.

The basic unit is the "Field of Research" and this tends to correspond, for the most part, to the traditional departments in Medical Schools. However, work occurring in a particular department which is more usually identified with another field appears as part of that field rather than under the departmental heading. For instance, much of the activity proceeding in the Banting and Best Department of Medical Research in Toronto has been classified as biochemistry while several of the projects in progress in the Department of Biophysics at Western have been classified as physiology. It is not, therefore, possible to directly derive the departmental support from the tables provided.

In the case of clinical investigators, notably those in the Hospital for Sick Children, a judgment was made and some have been assigned to a basic science classification while others are credited to the appropriate clinical field.

For the most part only those investigators supported by grants-in-aid are included (intramural as well as extramural grants have been included when known) but in a few instances (e.g. therapeutic radiology) investigators known to be active but not receiving identified support have been counted in the personnel section. In a few cases, part-time projects in which there was no evidence of current activity have been excluded.

All reasonable effort has been made to include workers who have, for one reason or another, not been identified in the raw data. Reference has been made to compiled lists of grants-in-aid and most, if not all, grantees appeared in the primary data submitted by the institution. This kind of cross check has been possible with only some of the raw data and it seems probable that a small number of individuals may have been missed.

In the view of the authors, perhaps the least satisfactory aspect of the study is the classification which was imposed to allow analysis. This was developed with a minimum of consultation and is recognised to be unsatisfactory in some respects. Classification by field of research is arbitrary and projects do not appear under more than one heading. Because of this restriction the sums that appear in particular categories do not necessarily represent all of the funds being expended in the field since related studies may appear under other headings. In spite of this, however, we believe the general conclusions which can be drawn from this data are probably valid.

RESULTS

These consist of an outline of the classification of the fields suitable for computer analysis and four tables describing various aspects of the data.

The cost data are based solely on the value of grants-in-aid. Institutional overhead, salary costs of investigators, and other indirect costs have not been considered. Accordingly, it should be emphasised that the true cost of the research activity is substantially larger than that indicated in the attached tables.

The total research funding identified in this study amounting to about 14.5 million dollars is approximately four million dollars less than is commonly estimated as the total cost of "medical" research proceeding in this Province. This difference is probably accounted for in part by incomplete reporting in the present study but also perhaps more importantly by our inability to adequately survey research establishments (e.g. Alcohol Research Foundation) and other agencies in the health field (e.g. Dentistry, Nursing, etc.).

CONCLUSIONS

1. There appear to be more individuals engaged in some form of "clinical" research than there are in "basic" areas although the total expenditure of funds on the "basic" side closely approximates that on "clinical" research. This may reflect the fact that the smaller "basic" group spends a higher proportion of its time on investigation. Another factor which may also operate is the fact that some of the data used by the "clinical" group is obtained coincident with investigation of the patient and is accordingly chargeable to accounts other than research accounts. This factor would tend to reduce the mean cost per investigator and this lower cost is evident (e.g. Table III). Some investigative activity on the "clinical" side (e.g. therapeutic radiology and some aspects of psychiatry) may normally derive its support by routes other than grants-in-aid and this factor will also tend to reduce the "cost per investigator".

2. The data reveal obvious disparities in the funding of research in the various Medical Schools. The amount of research carried on by a particular School does not seem to be directly tied to the number of undergraduate students. Factors such as the age of the School, the size of the associated University and perhaps the character and size of the Medical School may be determining factors in this difference.

3. Detailed review of the data on the basis of individual titles has revealed negligible duplication of effort amongst the Medical Schools of the Province.

4. Detailed review also shows that while there are undoubtedly efforts at interdisciplinary study the amount of this potentially fruitful activity remains comparatively small. The prevailing pattern within defined fields of research is one of diversity of interest rather than concentration of effort on one subject area.

5. The mean operating cost per investigator in the form of grants-in-aid varies considerably from one field of research to another but nonetheless a figure of $20,000 per investigator per annum seems a reasonable average figure for the year 1969.

Table I

NUMBER OF PERSONNEL IDENTIFIED AS PRINCIPAL INVESTIGATORS *

(MEDICAL SCHOOLS OF ONTARIO)

FIELD OF RESEARCH**	McMASTER	QUEEN'S	OTTAWA	TORONTO	WESTERN	TOTAL
Anatomy	2.0	4.0	13.0	4.0	22.5	45.5
Biochemistry	10.0	12.0	10.0	37.5	20.0	89.5
Biophysics	-	1.0	-	24.75	4.0	29.75
Microbiology	-	10.0	4.0	25.0	8.0	47.0
Oncology	-	1.0	-	3.5	10.75	15.25
Pathological Chemistry	-	-	1.0	10.5	4.0	15.5
Pharmacology	-	2.0	6.0	14.0	5.75	27.75
Physiology	-	15.5	7.0	26.25	21.0	69.75
Nutrition	-	-	-	8.0	-	8.0
Veterinary Medicine	-	-	-	1.0	-	1.0
SUB TOTAL	12.0	45.5	41.0	154.5	96.0	349.0
Anesthesia	-	1.0	-	9.5	3.0	13.5
Medicine	8.0	18.0	10.25	77.5	14.0	127.75
Obstetrics & Gynecology	4.0	5.0	4.0	13.0	5.0	31.0
Pathology	6.0	15.0	7.0	12.0	12.0	52.0
Pediatrics	6.0	1.0	1.0	19.5	8.0	35.5
Surgery	4.0	13.0	11.0	30.0	8.0	66.0
Diagnostic Radiology	2.0	-	-	5.0	1.0	8.0
Therapeutic Radiology	-	-	-	9.0	-	9.0
Otolaryngology	-	-	-	6.0	1.75	7.75
Ophthalmology	-	6.0	1.0	5.0	1.0	13.0
Psychiatry	5.0	17.0	1.0	8.0	9.0	40.0
Family Medicine	1.0	-	-	-	2.0	3.0
Health Administration	-	-	-	2.0	-	2.0
Rehabilitation Medicine	-	-	-	9.0	-	9.0
Child Development	1.0	-	-	-	-	1.0
Behavioural Disorders	1.0	-	-	2.0	3.0	6.0
Epidemiology	3.0	10.0	2.0	2.0	7.0	24.0
Unclassified	-	1.0	-	-	-	1.0
SUB TOTAL	41.0	87.0	37.25	209.5	74.75	449.50
TOTAL	53.0	132.5	78.25	364.0	170.75	798.5

* Survey performed in period of June - September, 1969.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

Table II

FUNDS COMMITTED TO RESEARCH AS GRANTS-IN-AID*

(MEDICAL SCHOOLS OF ONTARIO)

FIELD OF RESEARCH**	McMASTER	QUEEN"S	OTTAWA	TORONTO	WESTERN	PROVINCIAL TOTAL
Anatomy	47,500	24,200	277,960	47,400	197,899	594,959
Biochemistry	197,700	214,000	281,000	1,005,613	335,231	2,033,544
Biophysics	-	40,000	-	555,020	36,285	631,305
Microbiology	-	242,000	98,870	758,022	121,037	1,219,929
Oncology	-	8,700	-	87,360	477,810	573,870
Pathological Chemistry	-	-	8,000	115,100	15,600	138,700
Pharmacology	-	111,000	110,700	360,882	115,668	698,250
Physiology	-	296,000	86,750	556,488	244,230	1,183,468
Nutrition	-	-	-	154,000	-	154,000
Veterinary Medicine	-	-	-	52,000	-	52,000
SUB TOTAL	245,200	935,900	863,280	3,691,885	1,543,760	7,280,025
Anesthesia	-	15,000	-	35,000	9,850	59,850
Medicine	139,350	406,000	123,750	1,738,010	285,900	2,693,010
Obstetrics & Gynecology	70,000	54,000	29,000	121,375	45,000	319,375
Pathology	152,500	186,000	143,000	266,863	114,530	862,892
Pediatrics	159,000	22,000	10,000	630,700	50,500	872,200
Surgery	70,788	125,000	162,100	577,387	81,971	1,017,246
Diagnostic Radiology	13,300	-	-	24,817	4,600	42,717
Therapeutic Radiology	-	-	-	-	-	-
Otolaryngology	-	-	-	103,780	9,000	112,780
Ophthalmology	-	40,500	20,000	254,075	1,700	316,275
Psychiatry	71,356	82,700	10,725	131,805	19,750	316,336
Family Medicine	49,000	-	-	-	21,450	70,450
Health Administration	-	-	-	35,000	-	35,000
Rehabilitation Medicine	-	-	-	43,000	-	43,000
Child Development	23,034	-	-	-	-	23,034
Behavioural Disorders	21,227	-	-	36,460	-	57,687
Epidemiology	44,300	162,200	7,500	55,300	61,769	331,069
Unclassified	-	8,000	-	-	-	8,000
SUB TOTAL	813,855	1,101,400	506,075	4,053,572	706,020	7,180,922
TOTAL	1,059,055	2,037,300	1,369,355	7,745,457	2,249,780	14,460,947

* Survey performed in the period June - September, 1969.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

Table III

MEAN COST PER INVESTIGATOR AND COST DISTRIBUTION

(MEDICAL SCHOOLS OF ONTARIO)

FIELD OF RESEARCH **	Number of Personnel	Support in Dollars	Dollars per Investigator	Percent of dollars Sub-total	Percent of dollars Total
Anatomy	45.5	594,959	13,076	8.17	4.12
Biochemistry	89.5	2,033,544	22,721	27.93	14.09
Biophysics	29.75	631,305	21,220	8.67	4.37
Microbiology	47.0	1,219,929	25,956	16.75	8.45
Oncology	15.25	573,870	37,630	7.88	3.97
Pathological Chemistry	15.5	138,700	8,948	1.90	0.96
Pharmacology	27.75	698,250	25,162	9.59	1.83
Physiology	69.75	1,183,468	16,967	16.25	8.20
Nutrition	8.0	154,000	19,250	2.11	1.06
Veterinary Medicine	1.0	52,000	52,000	0.71	0.36
Sub-total	349.0	7,280,025	20,860	100.00	100.00
Anesthesia	13.5	59,850	4,433	0.83	0.41
Medicine	127.5	2,693,010	21,122	37.50	18.76
Obstetrics & Gynecology	31.0	319,375	10,302	4.44	2.22
Pathology	52.0	862,892	16,594	12.01	6.01
Pediatrics	35.5	872,200	24,569	12.15	6.07
Surgery	66.0	1,017,246	15,413	14.16	7.09
Diagnostic Radiology	8.0	42,717	5,340	0.59	0.29
Therapeutic Radiology	9.0	-	-	-	-
Otolaryngology	7.75	112,780	14,552	1.57	0.78
Ophthalmology	13.0	316,275	24,329	4.40	2.20
Psychiatry	40.0	316,336	7,908	4.40	2.20
Family Medicine	3.0	70,450	23,483	0.98	0.49
Health Administration	2.0	35,000	17,500	0.48	0.24
Rehabilitation Medicine	9.0	43,000	4,778	0.59	0.29
Child Development	1.0	23,034	23,034	0.32	0.16
Behavioural Disorders	6.0	57,687	9,598	0.80	0.40
Epidemiology	24.0	331,069	13,795	4.61	2.30
Unclassified	1.0	8,000	8,000	0.11	0.05
Sub-total	449.5	7,180,922	15,975	100.00	
TOTAL	798.50	14,431,947	18,074		100.00

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

April, 1970

Table IV (a)

PERSONNEL AND COST DISTRIBUTION (BASIC SCIENCE)

(MEDICAL SCHOOLS OF ONTARIO)

FIELD OF RESEARCH**	SUBDISCIPLINE*	PERSONNEL	SUPPORT IN DOLLARS	EXTRAMURAL DOLLARS PER INVESTIGATOR	% TOTAL		CODE
					PERSONNEL	FUNDS	
Anatomy	Gross	10.5	108,494	10,333	23.0	18.2	111-115
	Histology	15.0	250,271	16,685	33.0	42.1	121-125
	Cytology	8.0	167,141	20,893	17.6	28.1	131-135
	Cytogenetics	12.0	69,053	5,754	26.4	11.6	141
	TOTALS	45.5	594,959	13,076	100.0	100.0	
Biochemistry	Energy metabolism & mitochondrion	5.0	105,594	21,118	5.58	5.21	211
	Intermediary metabolism & control mechanisms	12.0	211,000	17,583	13.40	10.41	212
	Carbohydrate, lipid & protein	23.0	701,669	30,507	25.69	34.62	214
	Other types metabolism	3.0	37,451	12,484	3.35	1.84	
	Endocrinology & differentiation	15.5	337,372	21,766	17.31	16.30	221-225
	Membranes	8.0	125,583	15,698	8.93	6.19	231-234
	Nucleic acids	6.0	135,900	22,650	6.70	6.70	241-244
	Protein synthesis, degradation or structure	8.0	199,620	24,953	8.93	9.85	251
	Immunochemistry	3.0	63,460	21,153	3.35	3.13	252
	Physical chemistry of macromolecules	3.0	59,895	19,965	3.35	2.95	253
	Protein nature of enzymes	3.0	56,000	18,667	3.35	2.76	255
	TOTALS	89.5	2,033,544	22,721	100.0	100.0	
Biophysics	Radiobiology	6.0	172,040	28,673	20.60	27.25	321-322
	Molecular biology:						
	- Nucleic acid & genetics	4.0	130,000	32,500	13.44	20.59	331
	- Protein structure	2.0	4,000	2,000	6.72	0.63	332
	- Molecular morphology	5.0	53,985	10,797	16.80	8.55	333
	- Immunobiology	3.0	138,250	46,083	10.08	21.89	334
	- Cell proliferation	2.0	13,200	6,600	6.72	2.09	335
	Biomedical electronics	7.75	119,830	15,462	26.10	19.0	341-344
	TOTALS	29.75	631,305	21,220	100.0	100.0	

* See classification of fields of research.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

Table IV (a) - page 2

FIELD OF** RESEARCH	SUBDISCIPLINE*	PER-SONNEL	SUPPORT IN DOLLARS	EXTRA-MURAL DOLLARS PER INVES-TIGATOR	% TOTAL		CODE
					PER-SONNEL	FUNDS	
Microbiology	Bacteriology:						
	- Biochemical aspects	5.50	76,199	13,854	11.70	6.24	411
	- Metabolism	3.0	28,550	9,517	6.38	2.34	412
	- Morphology	4.0	78,500	19,625	8.51	6.43	413
	- Other	2.20	15,600	7,091	4.68	1.27	414-415
	Virology:						
	- Biochemical aspects	4.0	143,580	35,895	8.51	11.76	421
	- Bacteriophage	1.0	7,000	7,000	2.12	0.57	422
	- Virus in tissue culture	1.0	107,422	107,422	2.12	8.80	425
	- General	5.80	154,270	26,598	12.34	12.64	426
	Immunology:						
	- Bacterial antigens	1.0	22,879	22,879	2.12	1.87	431
	- General	5.0	127,000	25,400	10.63	10.41	432-434
	Parasitology	5.0	61,770	12,354	10.63	5.06	441-445
	Medical microbiology	6.0	76,695	12,782	12.76	6.28	451-453 and 455
	Antibiotics & Chemotherapy	3.5	320,464	91,561	7.44	26.26	454
	TOTALS	47.0	1,219,929	25,956	100.0	100.0	
Oncology	Morphology:						
	- Cytogenetics	1.0	8,700	8,700	6.55	1.51	521
	- General	1.5	37,000	24,667	9.83	6.44	522
	- Stem cells	1.0	61,468	61,468	6.55	10.71	523
	Carcinogenesis:						
	- Nucleic acids	7.0	427,810	61,116	45.90	74.54	531
	- Other	1.5	9,192	6,128	9.83	1.60	532-534
	Specific & experi-mental tumors	3.25	29,700	9,138	21.32	5.17	541-545
	TOTALS	15.25	573,870	37,631	100.0	100.0	
Pathological Chemistry	Endocrinology & Metabolism	2.50	57,120	22,848	16.12	41.18	611
	In vivo monitoring	2.00	15,600	7,800	12.90	11.24	612
	Fluids & electrolytes	3.00	-	-	19.35	-	614
	Proteins, amino acids & enzymes	4.00	31,400	7,850	25.80	22.63	615
	Other	4.00	34,580	8,645	25.80	24.93	616
	TOTALS	15.50	138,700	8,948	100.0	100.0	

Table IV (a) - page 3

FIELD OF** RESEARCH	SUBDISCIPLINE*	PER-SONNEL	SUPPORT IN DOLLARS	EXTRA-MURAL DOLLARS PER INVES-TIGATOR	% TOTAL		CODE
					PER-SONNEL	FUNDS	
Pharmacology	Neuropharmacology:						
	- Central nervous system	1.67	47,290	28,317	6.01	5.86	711
	- Autonomic nervous system	4.0	128,500	32,125	14.41	18.58	712
	- Other	1.67	25,800	15,449	6.01	3.73	713
	Cardiovascular & blood:						
	- Effects of drugs	5.83	80,268	13,768	21.0	11.60	721
	- Effects of hormones	2.0	37,000	18,500	7.20	5.35	722
	- Blood clotting	1.5	18,000	12,000	5.40	2.60	725
	Biochemical & cellular:						
	- Pharmacogenetics	1.0	20,000	20,000	3.60	2.89	731
	- Mechanism of drug actio	2.0	155,000	77,500	7.20	22.41	733
	- Membrane phenomena	2.0	47,100	23,550	7.20	6.81	734
	Clinical pharmacology	2.58	71,746	27,809	9.29	10.37	741
	Biostatistics	1.0	2,500	2,500	3.60	0.36	751
	Toxicology	2.5	65,046	26,018	9.0	9.40	761
	TOTALS	27.75	698,250	25,162	100.0	100.0	
Physiology	Carbohydrate, lipid & protein metabolism	3.0	26,780	8,927	4.42	2.28	811
	Pituitary pancreas & adrenal	10.0	211,529	21,153	14.76	18.07	812
	Reproductive endocrinology	2.0	36,200	18,000	2.95	3.09	813
	Muscle & exercise	8.25	150,766	18,275	10.70	12.45	814
	Neuroendocrine	5.0	125,838	25,168	7.38	10.58	815
	General metabolism & endocrinology	2.5	27,000	10,800	2.95	2.26	816
	Blood volume, salt & water	6.0	104,400	17,400	8.85	8.91	821
	Special circulatory areas	5.0	59,500	11,900	6.64	4.61	822
	Renal & diuretics	3.0	36,775	12,258	4.42	3.14	823
	General cardiovascular & renal	3.0	42,780	14,260	4.42	3.65	824-825
	Neurophysiology:						
	- Electrical activity of neurones	5.0	64,000	12,800	2.38	5.46	831
	- Computer applications	1.0	4,000	4,000	1.47	0.34	832
	- Foetal & uterine electrophysiology	1.0	7,350	7,350	1.47	0.62	833
	- Reflex mechanisms	2.0	22,000	11,000	2.95	1.87	834
	- General	4.0	72,500	18,125	5.90	6.19	
	Blood clotting	2.0	42,150	21,075	2.95	3.60	841
	Respiration	2.0	3,000	1,500	2.95	0.25	842-843
	Gastrointestinal	0.5	27,000	54,000	0.73	2.30	851
	Experimental surgery	1.0	20,000	20,000	1.47	1.70	852
	Special senses	1.0	7,900	7,900	1.47	0.67	854
	Environmental	2.0	80,000	40,000	2.95	6.83	855
	Applied physiology	0.5	12,000	24,000	0.73	1.02	861
	TOTALS	69.75	1,183,468	16,967	100.0	100.0	

Table IV (a) - page 4

FIELD OF** RESEARCH	SUBDISCIPLINE*	PER-SONNEL	SUPPORT IN DOLLARS	EXTRA-MURAL DOLLARS PER INVES-TIGATOR	% TOTAL		CODE
					PER-SONNEL	FUNDS	
Nutrition	Vitamins:						
	- Fat soluble vitamins	2.0	26,000	13,000	25.0	16.88	911
	- Physiological aspects	2.0	26,000	13,000	25.00	16.88	913
	- Metabolic effects	1.5	47,000	31,333	18.75	30.51	914
	Dietary evaluation:						
	- Food habits	2.0	44,000	22,000	25.0	28.57	921
	- Evaluation of diets	0.5	11,000	22,000	6.25	7.14	923
	TOTALS	8.0	154,000	19,250	100.0	100.0	
Veterinary Medicine		1.0	52,000	52,000	-	-	1011
	SUB-TOTAL -- BASIC	347.0	7,166,530	20,653	-	-	

* See classification of fields of research.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

April, 1970

Table IV (b)

PERSONNEL AND COST DISTRIBUTION (CLINICAL SCIENCE)

(MEDICAL SCHOOLS OF ONTARIO

FIELD OF RESEARCH**	SUBDISCIPLINE*	PER-SONNEL	SUPPORT IN DOLLARS	EXTRA-MURAL DOLLARS PER INVES-TIGATOR	% TOTAL		CODE
					PER-SONNEL	FUNDS	
Anesthesia	Clinical	8.5	51,850	6,100	63.0	86.6	1111-1115
	Applied physiology	4.0	-	-	29.6	-	1121-1125
	Applied pharmacology	1.0	8,000	8,000	7.4	13.4	1131-1134
	Unclassified	-	-	-	-	-	1141
	TOTALS	13.5	59,850	4,433	100.0	100.0	
Medicine	Cancer	9.25	429,087	46,388	7.24	15.93	1211-1215
	Endocrinology	11.0	260,900	23,718	8.61	9.68	1221-1222
	Metabolism	16.75	366,884	21,904	13.11	13.62	1223-1225
	Cardiovascular & respiratory	23.0	398,761	17,337	18.0	14.8	1231-1235
	Immunology, allergy & rheumatology	15.5	352,636	22,751	12.13	13.09	1241
	Gastroenterology & hematology	19.5	326,598	16,749	15.26	12.12	1242
	Nephrology	6.5	112,604	17,324	5.08	4.18	1243
	Other specialties	20.5	378,190	-	16.04	14.04	1244-1245
	Clinical pharmacology	5.75	67,350	18,448	4.50	2.50	1251-1255
	TOTALS	127.75	2,693,010	21,080	100.0	100.0	
Obstetrics & Gynecology	Cancer	4.0	18,000	4,500	12.90	5.63	1311-1315
	Clinical obstetrics	5.0	60,000	12,000	16.12	18.78	1321-1325
	Perinatal care	8.0	99,475	12,434	25.80	31.14	1331-1334
	Applied physiology	9.75	140,900	14,451	31.45	44.11	1341-1345
	Miscellaneous	4.25	1,000	235	13.70	0.31	1351-1355
	TOTALS	31.0	319,375	10,302	100.0	100.0	
Pathology	Cancer	12.0	229,882	19,157	23.07	26.64	1411-1415
	Cardiovascular & respiratory	9.5	225,730	23,761	18.26	26.15	1421-1424
	Applied basic disciplines	12.5	206,181	16,494	24.03	23.89	1431-1435
	Systems	13.0	161,500	12,423	25.0	18.71	1441-1445
	Other	5.0	39,600	7,920	9.61	4.58	1451-1454
	TOTALS	52.0	862,893	16,594	100.0	100.0	

* See classification of fields of research.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

Table IV (b) - page 2

FIELD OF RESEARCH**	SUBDISCIPLINE*	PERSONNEL	SUPPORT IN DOLLARS	EXTRAMURAL DOLLARS PER INVESTIGATOR	% TOTAL PERSONNEL	% TOTAL FUNDS	CODE
Pediatrics	Cancer	1.25	33,700	26,960	3.52	3.86	1511-1515
	Applied basic disciplines	2.75	80,600	29,309	7.74	9.24	1521-1525
	Cardiovascular & respiratory	5.75	185,100	32,191	16.19	21.22	1531-1532
	Endocrine & metabolism	4.0	160,500	26,625	11.26	18.40	1533
	Gastrointestinal	1.0	29,400	29,400	2.81	3.37	1534
	Other specialties	16.0	229,800	14,363	45.07	26.34	1535
	Genetics	4.75	153,100	32,232	13.38	17.55	1541-1543
	TOTALS	35.5	872,200	23,048	100.0	100.0	
Surgery	Cancer	10.0	191,426	19,143	15.15	18.81	1611-1615
	Heart	4.0	93,800	23,450	6.06	9.22	1621-1622
	Vascular	5.0	84,188	16,838	7.57	8.27	1623
	Vascular transplantation	3.0	79,600	26,533	4.54	7.82	1624
	Other cardiovascular	5.0	113,001	22,600	7.57	11.10	1625
	Orthopedics	6.0	104,628	26,157	9.09	10.28	1631-1636
	Urology	6.5	64,550	9,931	9.84	6.34	1641
	Plastic	5.0	43,000	8,600	7.57	4.22	1642
	General	6.0	40,150	6,692	9.09	3.94	1643
	Transplantation	3.0	36,000	12,000	4.54	3.53	1644
	Other specialties	6.0	38,000	6,333	9.09	3.73	1651
	Shock	2.0	80,903	40,452	3.03	7.95	1652
	Metabolism	0.5	23,000	46,000	0.75	2.26	1653
	Others	4.0	25,000	6,250	6.06	2.45	1654
	TOTALS	66.0	1,017,246	15,413	100.0	100.0	
Diagnostic Radiology		8.0	42,717	5,340	-	-	1711-1715
Therapeutic Radiology		9.0	-	-	-	-	1812
Otolaryngology	Cancer	1.0	46,480	46,480	12.90	41.21	1721
	Clinical	3.75	25,050	6,680	48.38	22.21	1722
	Applied physiology	3.00	41,250	13,750	38.70	36.57	1723
	TOTALS	7.75	112,780	14,552	100.0	100.0	

Table IV (b) - page 3

FIELD OF** RESEARCH	SUBDISCIPLINE*	PER-SONNEL	SUPPORT IN DOLLARS	EXTRA-MURAL DOLLARS PER INVES-TIGATOR	% TOTAL PER-SONNEL	% TOTAL FUNDS	CODE
Ophthalmology	Clinical	5.0	193,055	38,611	38.46	61.04	1731
	Eye bank	1.0	86,520	86,520	7.69	27.35	1733
	Applied basic science	3.0	29,200	9,733	23.07	9.23	1734
	Other	4.0	7,500	1,875	30.76	2.37	1735
	TOTALS	13.0	316,275	24,329	100.0	100.0	
Psychiatry	Clinical pharmacology	1.0	6,714	6,714	2.50	2.12	1741
	Psychotherapy	6.0	94,288	15,715	15.00	29.80	1742
	Psychosomatic	3.0	17,329	5,776	7.50	5.47	1743
	Psychoneurosis and psychosis	4.5	22,480	4,996	11.25	7.10	1744
	Other	25.5	175,525	6,883	63.75	55.48	1745
	TOTALS	40.0	316,336	7,908	100.0	100.0	
Family Medicine		3.0	70,450	23,483	-	-	1811,1821
Health Administration		2.0	35,000	17,500	-	-	1814
Rehabilitation Medicine		9.0	43,000	4,773	-	-	1813
Child Development		1.0	23,034	23,034	-	-	1815
Behavioural Disorders		6.0	57,687	9,615	-	-	1816
Epidemiology		24.0	331,069	13,795	-	-	1817,1822
Unclassified		1.0	8,000	8,000	-	-	1823
	SUB-TOTAL -- CLINICAL	449.50	7,180,922	15,975	-	-	

* See classification of fields of research.

** The "field of research" is not synonymous with departmental affiliation. These do not represent departmental activity.

Page

SECTION III: SPECIALIZED MANPOWER PRODUCTION: 1965-1975

III SPECIALIZED MANPOWER PRODUCTION: 1965-1975

(a) GRADUATE DEGREE PROGRAMMES:

METHODS:

The following disciplines were recognized in this category: Anatomy, Biochemistry, Biomedical Engineering, Cancer Research, Medical Sciences, Epidemiology and Community Health, Microbiology and Immunology, Pathology, Pathological Chemistry, Pharmacology and Physiology.

In each of these disciplines the following information was obtained from each Ontario Medical School for each academic year.

M.Sc - No. of students registered per year.
- No. of M.Sc graduates per year.

Ph.D - No. of students registered per year.
- No. of Ph.D graduates per year.

Research Fellows (not proceeding to degree, not on academic staff, i.e., usually post-doctoral fellows.)

RESULTS:

The data is presented in Appendix A and B. Appendix A shows the breakdown of this information for each discipline by Medical School for each academic year between 1965 and 1975. Appendix B shows the provincial totals for four of the years in the decade under study: 1965-66, 1968-69, 1971-72 and 1974-75.

In making assessments as to whether or not there is under, appropriate, or over production of manpower in these graduate degree programmes the following deficiencies in our information must be recognized:

(1) No information was obtained on the numbers of M.D.'s in these programmes.

(2) No information was available on the percentage of Ontario graduate students that stay in the Province following completion of their degree programme.

(3) No information was available on the number of people with M.Sc or Ph.D degrees from outside the Province that come to Ontario each year.

(4) The attrition rate was not known.

(5) The current manpower situation was not assessed.

(6) No figures were available on the projected manpower requirements in these disciplines.

(7) The figures regarding the number of graduate students registered per year were essentially complete. In some instances the output of graduate students were not provided, in which case the outputs were calculated on the basis of an M.Sc degree requiring two years and a Ph.D degree requiring four years.

It should be noted that McMaster Medical School has separate graduate degree programmes in Biochemistry, Epidemiology and Neurosciences. Degree programmes for all other disciplines are included under Medical Sciences.

Anatomy. There is a planned sevenfold increase in output of M.Sc and Ph.D anatomists over the decade 1965-75. The output of M.Sc anatomists per year will increase by 14 (from 4 to 18) while the output of Ph.D anatomists will increase from 0 to 11. It would seem certain that the Departments of Anatomy in Ontario Medical Schools could not absorb this output. However, since these graduate degrees will be in fields such as cancer research, genetics, electron microscopy and immunology (to name a few) aside from Anatomy, Histology, Embryology, etc. the output may all be absorbed. Moreover there is no assurance that the enrolment predictions will be fulfilled in this discipline.

Biochemistry. The output of M.Sc biochemists per year will increase by 37 (11 to 48) from 1965 to 1975 while the output of Ph.D biochemists per year will increase by 40 (7 to 47) over the decade. Ontario Departments of Biochemistry are generally well staffed now. Where will these graduate students find jobs in Ontario? If they are physicians, research positions in clinical disciplines may be open. A number may choose to help fill the deficiencies in Clinical Chemistry. If so, the appropriateness of an academic training in Biochemistry for this purpose should be reviewed. If enrolment predictions are fulfilled in this discipline, which is a distinct possibility, there would appear to be developing a serious over-production of academic manpower in Biochemistry.

Biomedical Engineering. There were no M.Sc or Ph.D graduates in this field in 1965-66. It is projected there will be 11 M.Sc and two Ph.D graduates in 1974-75. The numbers listed in Appendix A and B in this field are almost entirely from the Institute of Biomedical Electronics, University of Toronto. Thus, the entirely inadequate output in this discipline will be electronically (versus biophysically, etc.) oriented. Considering that this rapidly developing (elsewhere) and increasingly important (everywhere) field is often the core of interdisciplinary research efforts (which the Ontario Council of Health wishes to encourage) the deficiency in manpower production in this discipline is glaring. More programmes of Biomedical Engineering are urgently required!

Cancer Research. The yearly output of M.Sc and Ph.D graduates in this discipline, which will double from 1965 to 1975, is from the Institute of Cancer Research, University of Western Ontario, and from the Department of Medical Biophysics, University of Toronto. The graduates in this discipline will basically be molecular biologists with a special interest in the application of this science to the cancer field. The yearly M.Sc output will rise from 5 in 1965-66 to 14 in 1974-75. The yearly Ph.D. output will rise very little (from 8 to 10) over this decade. It is of considerable importance to note that, although the increase in output of Ph.D's in this field is minimal, senior workers in this field are already cutting back on the number of Ph.D students they take because of a lack of suitable employment opportunities.

Medical Sciences. There were no M.Sc or Ph.D graduates in Medical Science in 1965-66. There will be two M.Sc graduates in 1968-69. If enrolment projections materialize, in 1974-75 there will be 43 M.Sc graduates and 26 Ph.D graduates - half of the graduates in each category will come from McMaster where Medical Science represents all disciplines except Biochemistry, Epidemiology and the Neurosciences. Thus, included in the McMaster figures are a proportion of individuals who would normally take their graduate studies in basic science disciplines. However, the majority of graduates in this discipline from McMaster as well as all other graduates in Medical Science will have an applied orientation making "Clinical Medical Science" a more appropriate label for their discipline.

In 1974-75 three of the five Medical Schools in Ontario will have degree programmes in Clinical Medical Science. The strong development in this field is important in that there has been very limited opportunity in Ontario for this type of training until the present. The development of Clinical Medical Sciences will add an important level of science to the practice and education in clinical medicine in Ontario and to the advancement of research which may be expected to influence the quality of health care. It is unfortunate however that the growth spurt in Clinical Medical Sciences is coming in Ontario at a time when the effects of tight money policy are greatly increasing the intensity of the competition for the limited research funds available.

Epidemiology and Community Health. The output of M.Sc graduates in this field will rise from 2 to 26 from 1965 to 1975 while the Ph.D output will rise from 1 to 5 in the decade. Over 60 per cent of the output comes from four departments in the School of Hygiene, Toronto. The Medical Schools themselves are almost without graduate programmes in this discipline at the present time. Considering the void that exists in this field, and the fact that the Provincial Government has announced a policy to support and develop research in Epidemiology and allied sciences a reassessment of the priority which should be given to research and training programmes in this discipline should be undertaken by Ontario Medical Schools now. Manpower production in this field is grossly deficient today and will remain so in the foreseeable future unless substantial incentives are given to its development.

Microbiology and Immunology (Bacteriology, Virology and Immunology.) M.Sc output in these fields will rise from 4 to 36 and Ph.D output from one to 20 over the decade 1965-75. These figures include the School of Hygiene, Toronto (Departments of Microbiology and Parasitology) and the new Department of Cell Biology, University of Toronto. The strong developments projected for Virology and Immunology are entirely appropriate considering the rapid advances in these fields. Great concern is expressed for the apparent lack of development in the field of Bacteriology. This is considered to be serious. (See also Bacteriology, under Section II, Clinical Specialties, of Manpower Production, Tables I and III.)

Pathology. M.Sc output per year will rise from 6 to 24 and Ph.D output per year will rise from 0 to 12 over the decade 1965-75. The entire increase in output will occur between 1969 and 1975. Considering the general lack of pathologists and the inadequate level of research activity in this field, this increase in output will probably fall considerably short of manpower requirements. (See also Pathology, under Sections (b) and (c), Specialized Manpower Production, Tables V, VII and VIII.

Pathological Chemistry. There are but two Departments of Pathological Chemistry in the Province and both are projecting considerable expansion in their graduate programmes between 1970 and 1975. M.Sc and Ph.D outputs were one per year in 1965 whereas M.Sc output is projected at 22 and Ph.D output at 8 by 1975. If these graduates are mainly clinical chemists they will likely find jobs in the Province's hospital and community laboratories, but as noted in the discussion of Biochemistry the appropriateness of this type of academic training to the type of employment opportunity should be carefully evaluated.

Pharmacology. Manpower output figures for 1965-66 were incomplete. M.Sc output will rise from 9 to 20 per year from 1969 to 1975, and Ph.D output will rise from 5 to 14 over the same period. Considering the rapid expansion that is taking place in this discipline and the current lack of well trained personnel this projected increase in manpower production must be considered necessary.

Physiology. M.Sc output will rise from 4 to 46 per year and Ph.D output from 6 to 26 per year from 1965 to 1975. These projected outputs could represent over-production of manpower if the training is that of classical physiology for which manpower requirement may be limited. It should also be appreciated that there will be overlap in manpower production between Medical Sciences and Physiology. A legitimate case could be made for some diversion of effort in Physiology from the more conventional areas, to emerging areas such as biophysics, control systems and the neurosciences where academic manpower requirements are increasing.

RESEARCH FELLOWS:

The projected number of research fellows (i.e., mainly post-doctoral fellows) appears to be excessive mainly in Biochemistry (74 in 1974-75) which would parallel the projected over-production of graduate students in this field. There is also a projection of 40 post-doctoral fellows in Clinical Medical Science for one institution in 1974-75. The projection for research fellows in other fields is either appropriate or inadequate.

In summary, if enrolment predictions are realized, and manpower utilization patterns do not change, serious overproduction of M.Sc and Ph.D manpower by 1975 appears likely to occur in Biochemistry and probably also in Physiology. Serious underproduction of M.Sc and Ph.D manpower in Biomedical Engineering, Pathology, Epidemiology and Community Health, and Bacteriology (the latter included in Microbiology and Immunology) is evident at present and will not be corrected by 1975. In a number of the other disciplines with graduate degree programmes manpower overproduction is a distinct possibility.

APPENDIX A

GRADUATE DEGREE PROGRAMMES:

ENROLMENT AND OUTPUT BY DEPARTMENT

in

INDIVIDUAL FACULTIES OF MEDICINE

ANATOMY

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.S.		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER *																																																	
OTTAWA	1	0	1	0	0	1	1	3	1	0	4	1	3	1	0	4	1	3	0	0	5	2	3	3	0	5	1	3	1	0	8	2	4	1	0	8	5	5	2	0	8	3	8	5	0	8	3	8	3	0
QUEEN'S	3	2	1	0	4	5	1	1	1	4	8	1	2	1	3	15	5	3	1	3	6	3	3	2	2	6	2	3	2	3	6	2	4	1	3	8	2	4	1	3	10	4	5	2	5	10	5	5	2	5
WESTERN	3	2	6	0	0	6	1	7	1	0	7	1	7	2	0	11	4	9	3	0	6	3	10	3	0	6	3	10	3	0	6	3	10	4	0	6	3	10	3	0	6	3	10	3	0	6	3	10	4	0
TORONTO		0		0			1		0			3		0	0	6	1	6	1	0	5	2	5	1	0	7	3	5	1	1	8	4	6	1	2										15	7	10	2	5
TOTAL	7	4	8	0	4	12	4	11	3	4	19	6	12	4	3	36	11	21	5	3	22	10	21	9	2	24	9	21	7	4	28	11	24	7	5										39	18	33	11	10

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Numbers included under Clinical Medical Science at McMaster

BIOCHEMISTRY

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER																6	0	2	0	9	10	3	6	0	9	12	5	15	2	11	12	6	22	5	12	12	6	30	7	12	12	6	30	10	14	12	6	30	10	15
OTTAWA	10	6	6	4	2	8	7	5	5	3	9	8	7	6	3	11	9	11	6	4	11	9	11	9	4	12	11	12	9	5	14	12	15	12	5	15	12	15	12	7	15	15	17	15	7	17	15	19	18	9
QUEEN'S	4	1	2	0	0	2	1	1	1	1	4	0	3	1	1	5	0	3	0	1	10	2	4	2	0	11	3	4	1	1	11	5	5	3	1											12	6	6	4	1
WESTERN	12	1	13	1	2	10	2	15	3	2	9	2	15	4	3	12	2	18	3	4	13	3	19	3	4	14	3	20	4	5	14	3	20	4	5	15	4	20	4	5	15	4	21	4	5	15	4	21	4	5
TORONTO *		3		2			6		2			10		1		19	7	41	2	8	25	12	45	11	3 6 6	30	15	45	11	9 7	35	17	45	11	12 8											35	17	45	11	10 22 12
TOTAL		11		7			16		11			20		12		53	18	75	11	26	69	29	85	25	32	79	37	96	27	38	86	43	107	35	43											91	48	121	47	74

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Middle row of figures = Department of Biochemistry
Top row of figures (R.F. only) = Research Institute at Hospital for Sick Children.
Bottom row of figures (R.F. only) = Banting & Best Department of Medical Research.

BIOMEDICAL ENGINEERING

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER																																																
OTTAWA																																															
QUEEN'S																					1						1																	3	1			
WESTERN																																															
TORONTO																14	0	10	0	2	17	8	9	2	1	16	8	10	2	1	16	8	10	2	1								20	10	10	2	2
TOTAL																					18						9																	23	11	10	2	2

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

CANCER RESEARCH

(Institute of Cancer Research at University of Western Ontario, Department of Medical Biophysics, University of Toronto)

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																									
OTTAWA																									
QUEEN'S																									
WESTERN	5	3	1	0	1	4	1	3	0	0	5	3	4	0	0	2	1	6	1	0	6	0	8	1	4
TORONTO		2		8			3		5			3		4		17	14	25	4	23	18	9	27	7	14
TOTAL		5		8			4		5			6				19	15	31	5	23	24	9	35	8	18

	1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																									
OTTAWA																									
QUEEN'S																									
WESTERN	8	4	8	2	4	8	4	8	2	4	8	4	8	3	4	8	4	8	2	4	8	4	8	3	4
TORONTO	20	10	30	7	15	20	10	30	7	15											20	10	30	7	15
TOTAL	28	14	38	9	19	28	14	38	9	19											28	14	38	10	19

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Included under Clinical Medical Sciences

MEDICAL SCIENCES

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER *																					8	0	10	0	4	18	8	22	0	5	22	10	34	4	6	27	12	45	12	8	33	15	51	12	10	38	18	59	14	10
OTTAWA																																																	
QUEEN'S **	3	0	0	0	0	3	2	0	0	0	2	1	0	0	0	6	1	0	0	0	5	0	0	0	0	9	1	0	0	0	14	2	2	0	0	15	2	3	2	0	18	3	5	3	0	18	8	7	4	0
WESTERN																																																	
TORONTO ***																10	1	8	0	19	5	2	9	2	0	11	5	14	3	3	15	7	20	5	0										35	17	35	8	4
TOTAL	3	0	0	0	0	3	2	0	0	0	2	1	0	0	0	16	2	8	0	19	18	2	19	2	4	38	14	36	3	5	51	19	56	9	6										91	43	101	26	14

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Includes all graduate students registered for degrees in Faculty of Medicine except in fields of Biochemistry, Epidemiology and Neurosciences.
** Students registered for graduate degrees in Clinical disciplines.
*** Institute of Medical Science (graduate degrees in Clinical disciplines).

EPIDEMIOLOGY AND COMMUNITY HEALTH

DEPARTMENT OR DISCIPLINE

(The Toronto component in this field comes almost entirely from the School of Hygiene - Departments of Nutrition, Health Administration, Epidemiology and Biometrics, Physiological Hygiene)

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER																0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	2	0	0	0	3	3	0	0	0	3	3	0	0	0	3	3	0	0	0
OTTAWA																																																	
QUEEN'S																					1	1	0	0	0	2	1	1	0	0	2	1	1	0	0	2	1	1	0	0	2	2	1	1	0	2	2	1	1	0
WESTERN	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0
TORONTO*	12	2	7	1	2	13	6	10	2	2	15	5	6	0	2	17	5	10	1	2	20	9	10	2	2	23	10	11	3	2	25	11	12	3	2	23	13	12	3	2	30	14	13	3	2	386	183	144	31	2
TOTAL	12	2	7	1	2	13	6	11	2	2	15	5	7	0	2	17	5	11	1	2	21	10	11	3	2	26	12	13	3	2	29	14	14	3	2	28	17	14	4	2	35	19	15	4	2	49	26	20	5	2

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Top set of figures = School of Hygiene.
Bottom set of figures in 1974-75 = Department of Preventive Medicine, in Faculty of Medicine

MICROBIOLOGY AND IMMUNOLOGY
(Bacteriology, Virology and Immunology)

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																																																	
OTTAWA	0	0	3	0	0	0	0	3	0	0	1	0	4	2	0	2	0	6	0	0	2	2	7	0	0	4	2	8	2	0	4	2	8	3	1	4	2	8	3	1	6	2	8	2	2	6	3	10	3	2
QUEEN'S	8	2	5	1	0	3	8	9	0	1	7	2	9	1	0	9	2	10	1	1	8	5	11	5	1	8	5	12	4	2	8	6	12	3	2	8	6	12	5	3	8	6	12	4	4	8	6	12	3	4
WESTERN	0	0	2	0	0	2	2	1	1	0	1	3	1	1	0	9	9	7	1	0	9	4	7	2	0	9	5	7	2	0	9	4	7	2	0	9	5	7	2	0	9	4	7	2	0	9	3	7	3	0
TORONTO**	12	2	7	0	0	13	6	9	2		14	5	6	1		17 2	5 0	10 2	1 0	0 0	20 5	9 2	11 15	2 4	11	24 6	10 3	12 22	2 5	15	28 7	12 3	12 25	3 6	18	23	12	12	3		30	14	13	3		10 10	19 5	16 30	4 7	20
TOTAL	20	4	17	1	0	18	16	22	3	1	23	10	20	5	0	39	16	35	3	1	44	22	51	13	12	51	25	61	15	17	56	27	64	17	21	44	25	39	13	4	53	26	40	11	6	43	36	75	20	26

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Figures included in Clinical Medical Sciences.
** Top row of figures includes Departments of Microbiology & Parasitology of School of Hygiene + Department of Bacteriology in Faculty of Medicine (the latter contributes a very small proportion of total).
Bottom row of figures = Department of Cell Biology (Virology & Immunology)

PATHOLOGY

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																																																	
OTTAWA	1	1	0	0	2	0	0	0	0	3	0	0	1	0	2	1	0	1	0	4	1	0	1	1	3	2	1	1	0	2	2	2	1	0	2	4	2	2	1	4	4	4	2	0	4	4	4	2	2	4
QUEEN'S	4	2	0	0	0	4	3	1	0	0	1	1	1	0	0	3	1	1	0	0	4	2	1	0	0	5	3	2	1	0	6	4	2	1	0	7	5	2	1	0	8	6	2	1	0	8	6	2	2	0
WESTERN					1					1					1	5	0	2	0	1	5	2	4	1	1	6	3	5	2	2	7	3	6	3	2	8	4	6	4	2	8	4	6	5	2	8	4	6	6	2
TORONTO		3		0			3		0		3	3		3		4	4	3	0	8	4	2	2	0		6	3	6	1	0	8	4	8	2											20	10	10	2	15
TOTAL		6		0			6		0			4		3		13	5	7	0	13	14	6	8	2		19	10	14	4		23	13	17	6											40	24	20	12	21

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Included under Clinical Medical Sciences.

PATHOLOGICAL CHEMISTRY

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																									
OTTAWA																									
QUEEN'S																									
WESTERN	4	1	1	0	0	1	2	1	0	0	4	1	3	0	0	4	1	4	1	0	4	1	5	2	0
TORONTO		0		1	0		1		2	0		2		0	0	3	1	5	0	0	12	6	6	1	0
TOTAL		1		1	0		3		2	0		3		0	0	13	2	9	1	0	16	7	11	3	0

	1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																									
OTTAWA																									
QUEEN'S																									
WESTERN	4	1	6	2	0	5	2	8	2	0	5	2	10	3	0	6	2	12	3	0	6	2	14	3	0
TORONTO	15	7	7	2	0	18	9	8	2	0											40	20	20	5	4
TOTAL	19	8	13	4	0	23	11	16	4	0											46	22	34	8	4

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* McMaster figures included under Clinical Medical Sciences

PHARMACOLOGY

DEPARTMENT OR DISCIPLINE

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER *																																																	
OTTAWA	1	1	0	0	0	3	0	0	0	1	3	0	1	0	2	5	0	3	0	3	4	2	3	2	2	5	3	4	2	2	6	3	4	2	3	5	3	6	3	2	6	4	6	3	2	6	4	6	3	2
QUEEN'S	2	2	3	1	2	8	1	4	1	3	6	2	4	1	4	3	4	3	1	3	1	2	4	0	0	2	1	4	1	0	3	0	5	0	0	3	2	5	4	0	4	2	6	4	0	4	3	6	4	0
WESTERN						1	1		1	0	10	0		1	0	15	2	0	0	2	11	5	2	1	2	11	5	2	1	2	11	5	2	1	2	11	5	2	1	2	11	5	2	1	2	11	5	2	1	2
TORONTO		1		1			6		0			2		0		13	3	17	4	2	15	7	20	5	3	17	8	23	6	4	17	8	23	6	6										17	8	23	6	10
TOTAL							8		2			4		2		36	9	23	5	10	31	16	29	8	7	35	17	33	10	8	37	16	34	9	11										38	20	37	14	14

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Included under Clinical Medical Sciences

PHYSIOLOGY

DEPARTMENT OR DISCIPLINE

(Includes Department of Biophysics at University of Western Ontario and Neurosciences Division at McMaster)

	1965-66					1966-67					1967-68					1968-69					1969-70					1970-71					1971-72					1972-73					1973-74					1974-75				
	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF	M.Sc		Ph.D		RF
	R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O		R	O	R	O	
McMASTER*																									2	2	0	4	0	4	3	1	8	2	4	4	2	10	3	5	5	3	10	3	5					
OTTAWA	0	0	1	1	0	1	0	2	0	0	2	1	3	0	1	10	3	2	0	1	6	6	3	2	1	8	8	5	2	2	10	8	5	2	2	10	10	6	5	3	12	10	6	5	4	12	12	8	6	4
QUEEN'S	5	1	3	1	0	6	2	4	1	0	5	2	7	0	1	6	1	5	0	0	6	0	5	0	0	7	0	7	0	0																12	4	12	8	0
WESTERN**	9	2	2 6	1 1	0	7 1	6	5 7	0	0	7 2	2	10 5	0 3	2	13 1	2 1	9 10	1 1	4 1	14	7	10	5	2 1	15	7	10	3	3	15	7	10	3	3	20	10	12	4	4	20	10	12	4	4	20	10	12	4	4
TORONTO		1		2			3		2			6		1		24	6	18	2	6	27	13	18	4	4	28	14	20	5	5	30	15	20	5	5										35	17	20	5	5
TOTAL		4		6			11		3			11		4		54	13	44	4	12	53	26	36	11	8	58	29	42	10	12	57	30	39	10	14										84	46	62	26	18

Legend to Titles

RF = Research Fellow (not registered for degree, i.e., usually postdoctoral fellow)
R = Registered per year
O = Output per year

* Numbers listed at McMaster refer entirely to Neurosciences
** Top set of figures Physiology.
Bottom set of figures Biophysics.

APPENDIX B

GRADUATE DEGREE PROGRAMMES:

TOTAL ENROLMENT AND OUTPUT

ANATOMY*

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	7	4
	1968-69	36	11
	1971-72	28	11
	1974-75	39	18

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	8	0
	1968-69	21	5
	1971-72	24	7
	1974-75	33	11

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	15	4
	1968-69	57	16
	1971-72	52	18
	1974-75	72	29

Research Fellows	REGISTERED/YEAR	
	1965-66	4
	1968-69	3
	1971-72	5
	1974-75	10

* Anatomy at McMaster included under

Clinical Medical Sciences

BIOCHEMISTRY

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	11
	1968-69	53	18
	1971-72	86	43
	1974-75	91	48

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	7
	1968-69	75	11
	1971-72	107	35
	1974-75	121	47

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	-	18
	1968-69	128	29
	1971-72	193	78
	1974-75	212	95

Research Fellows	REGISTERED/YEAR	
	1965-66	-
	1968-69	26
	1971-72	43
	1974-75	74

BIOMEDICAL ENGINEERING

T O T A L S

M.Sc	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	-	-
1968-69	14	0
1971-72	16	8
1974-75	23	11

Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	-	-
1968-69	10	0
1971-72	10	2
1974-75	10	2

M.Sc + Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	-	-
1968-69	24	0
1971-72	26	10
1974-75	33	13

Research Fellows	REGISTERED/YEAR
1965-66	-
1968-69	2
1971-72	1
1974-75	2

CANCER RESEARCH*

(Institute of Cancer Research, University of Western Ontario. Department of Medical Biophysics, University of Toronto)

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	5
	1968-69	19	15
	1971-72	28	14
	1974-75	28	14

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	8
	1968-69	31	5
	1971-72	38	9
	1974-75	38	10

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	13
	1968-69	50	20
	1971-72	66	23
	1974-75	66	24

Research Fellows	REGISTERED/YEAR	
	1965-66	?
	1968-69	23
	1971-72	19
	1974-75	19

* McMaster figures included under

Clinical Medical Sciences

MEDICAL SCIENCES*

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR	
	1965-66	3	0	
	1968-69	16	2	
	1971-72	51 (22)	19	(10)
	1974-75	91 (38)	43	(18)

Ph.D.	REGISTERED/YEAR		OUTPUT/YEAR	
	1965-66	0	0	
	1968-69	8	0	
	1971-72	56 (34)	9	(4)
	1974-75	102 (59)	26	(14)

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR	
	1965-66	3	0	
	1968-69	24	2	
	1971-72	107 (56)	28	(14)
	1974-75	193 (97)	69	(32)

Research Fellows	REGISTERED/YEAR		
	1965-66	0	
	1968-69	19	(One institution)
	1971-72		
	1974-75	50	(40 at one institution)

* Medical Sciences at McMaster includes all disciplines except Biochemistry, Neurosciences and Epidemiology. The McMaster figures are noted in brackets.

EPIDEMIOLOGY AND COMMUNITY HEALTH

(Includes Departments of Nutrition, Epidemiology and Biometrics, Health Administration and Physiological Hygiene of School of Hygiene, Toronto)

T O T A L S

M.Sc.	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	12	2
1968-69	17	5
1971-72	29	14
1974-75	49	26

Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	7	1
1968-69	11	1
1971-72	14	3
1974-75	20	5

M.Sc + Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
1965-66	19	3
1968-69	28	6
1971-72	43	17
1974-75	69	31

Research Fellows	REGISTERED/YEAR
1965-66	2
1968-69	2
1971-72	2
1974-75	2

(Includes Departments of Microbiology and Parasitology, School of Hygiene, Toronto, plus Department of Cell Biology, Toronto)

MICROBIOLOGY AND IMMUNOLOGY*

(Bacteriology, Virology & Immunology)

T O T A L S

M.Sc	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66 16	4
	1968-69 39	16
	1971-72 56	27
	1974-75 73	36

Ph.D.	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66 17	1
	1968-69 35	3
	1971-72 64	17
	1974-75 75	20

M.Sc + Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66 33	5
	1968-69 74	19
	1971-72 120	44
	1974-75 148	56

Research Fellows	REGISTERED/YEAR
	1965-66 0
	1968-69 1
	1971-72 21
	1974-75 26

* McMaster figures included under Clinical Medical Sciences

PATHOLOGY*

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	6
	1968-69	13	5
	1971-72	23	13
	1974-75	40	24

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	0
	1968-69	7	0
	1971-72	17	6
	1974-75	20	12

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	6
	1968-69	20	5
	1971-72	40	19
	1974-75	60	36

Research Fellows	REGISTERED/YEAR		
	1965-66	?	
	1968-69	13	
	1971-72	?	
	1974-75	21	(15 at one institution)

* Pathology at McMaster included under Clinical Medical Sciences

PATHOLOGICAL CHEMISTRY*

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	1
	1968-69	13	2
	1971-72	23	11
	1974-75	46	22

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	1
	1968-69	9	1
	1971-72	16	4
	1974-75	34	8

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	2
	1968-69	22	3
	1971-72	39	15
	1974-75	80	30

Research Fellows	REGISTERED/YEAR	
	1965-66	0
	1968-69	0
	1971-72	0
	1974-75	4

* McMaster figures included under

Clinical Medical Sciences

PHARMACOLOGY*

T O T A L S

M.Sc	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66	
	1968-69 36	9
	1971-72 37	16
	1974-75 38	20

Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66	
	1968-69 23	5
	1971-72 34	9
	1974-75 37	14

M.Sc + Ph.D	REGISTERED/YEAR	OUTPUT/YEAR
	1965-66	
	1968-69 59	14
	1971-72 71	25
	1974-75 75	34

Research Fellows	REGISTERED/YEAR
	1965-66
	1968-69 10
	1971-72 11
	1974-75 14

* Pharmacology at McMaster is included under Clinical Medical Science

PHYSIOLOGY

(Includes Department of Biophysics at University of Western Ontario and Neurosciences at McMaster)

T O T A L S

M.Sc	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	4
	1968-69	54	13
	1971-72	?	?
	1974-75	84	46

Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	6
	1968-69	14	4
	1971-72	?	?
	1974-75	62	26

M.Sc + Ph.D	REGISTERED/YEAR		OUTPUT/YEAR
	1965-66	?	10
	1968-69	68	17
	1971-72	?	?
	1974-75	146	72

Research Fellows	REGISTERED/YEAR	
	1965-66	-
	1968-69	12
	1971-72	-
	1974-75	18

III SPECIALIZED MANPOWER PRODUCTION

(b) CLINICAL SPECIALTIES

Table V lists for each of 15 clinical specialties the number of residents and fellows registered in 1969-70 and to be registered in 1974-75, as well as the projected manpower output in these same years.

General Comments re Manpower Output in Clinical Specialties (Table V):

(1) The figures for manpower output per year are roughly 25 percent of the total number registered per year, which is as it should be with most of the specialty training programmes being four years in duration.

(2) The output of specialists will approximately double between 1970 and 1975. Forty percent of the increase in output of specialists is projected to occur in community medicine which is treated as a specialty in this Section. If these projections were to hold true, 20 percent of the specialty manpower output in 1975 would be in community medicine. [See Section III (Subspecialties, Manpower Report)].

(3) The output of trained specialists in 1975 would approximate the number of medical students graduating from Ontario Medical Schools in the same year.

Correlation of Projected Manpower Output in Clinical Specialties by this Survey with the Assessment of Specialty Needs by the Royal College of Physicians & Surgeons of Canada:

In attempting to assess the appropriateness of these manpower production figures (Table V), we have referred freely to information gathered by the Royal College of Physicians & Surgeons of Canada "Analysis of Specialist Needs, Ontario, June 1969". For reference, this information is included as Table VI. The validity of the Royal College data is mainly dependent on the correctness of the first column in Table VI "Suggested Criteria of Needs". It is quite possible that the criteria of need for any specialty has changed since it is our understanding that the figures in this column were established a few years ago. [A recent report on regional organization of health services by the Ontario Council of Health has suggested different criteria of need for some clinical specialties. For example, the Council of Health Report on Regionalization suggests that the neurosurgeon/population ratio should be 1/150,000 instead of 1/240,000 as listed by the Royal College of Physicians & Surgeons (Table VI)].

Other information from the Royal College of Physicians & Surgeons bears consideration. For the ten years 1959-68, 75 percent of Ontario Medical School graduates who have qualified as specialists have remained in Ontario, but 42 percent of specialists settling in Ontario during this period came from other provinces in Canada or other countries.

Comments concerning the appropriateness of specialist manpower production assume that the Royal College figures take into account a specialist attrition rate of about 3 percent per annum and the fact that the population of the Province is projected to increase by about 10 percent between 1970 and 1975 (from 7.45 to 8.14 million). In making the following assessments, by comparing the manpower production figures from this survey with the Royal College data, the current shortage in a specialty as well as the yearly requirement for maintenance of the current supply population ratio (Table VI) were taken into account.

Conclusions drawn by Comparing the Projected Output of Specialists in this Survey for 1970 and 1975 with the Royal College of Physicians & Surgeons Analysis (see Table VII):

1. Manpower production in the specialties of Anesthesia, Bacteriology, Otolaryngology and Therapeutic Radiology is inadequate in 1970 and will remain so in 1975. Manpower production in Rehabilitation Medicine is inadequate in 1970 but will be appropriate in 1975.

2. Manpower production in Obstetrics and Gynecology, Ophthalmology and Surgery is appropriate in 1970 and will remain so 1975. Manpower production in Medicine, Pediatrics and Pathology, although appropriate in 1970, will be excessive in 1975. It should be pointed out, however, that qualified specialists in Internal Medicine and Pediatrics frequently practise as primary physicians, making the actuality of excessive manpower production by 1975 less likely to occur. Similarly, excess manpower production is not likely to occur in Pathology because of the failure of this specialty to attract sufficient numbers of trainees.

3. Manpower production in Diagnostic Radiology and Psychiatry would appear to be excessive in 1970 and will be more so in 1975. It should be noted, however, that although the Royal College statistics suggest this, (1) Diagnostic Radiologists* continue to be in strong demand, and (2) the desired ratio of Psychiatrists to population may have changed from one per 15,000 to one per 10,000. If these considerations are true, then overproduction of manpower does not exist in 1970, nor will it in 1975.

In summary, although there is strong evidence of inadequate manpower production in one-third of the clinical specialties there would appear to be little danger of serious overproduction of manpower in the remaining specialties. It should be recognized that the pattern of delivery of health services in the Province will not be dictated entirely by the extent of growth of sub-specialty manpower which results from production at Ontario Medical Centres. An equally important consideration will be the market opportunity that is created which may be filled by graduates from other jurisdictions. This in turn is dependent on the organization of the health care delivery system and in particular the manner in which sub-specialty services are handled in smaller communities.

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* Recent information suggests that the Diagnostic Radiologist/population ratio should be at least 1/20,000, not 1/25,000, as listed in the Royal College figures (Table VI).

TABLE V

MANPOWER PROJECTIONS IN CLINICAL SPECIALTIES

SPECIALTY	1969-70				1974-75			
	REGISTERED			Output	REGISTERED			Output
	Residents	Fellows	Total		Residents	Fellows	Total	
ANESTHESIA	86	2	88	22	113	5	118	24
BACTERIOLOGY	4	0	4	1	19	0	19	7
COMMUNITY MEDICINE	46	0	46	10	286	6	292	113
MEDICINE	248	65	313	58	331	83	414	86
OBSTETRICS & GYNECOLOGY	62	3	65	11	83	5	88	22
OPHTHALMOLOGY	59	0	59	15	58	4	62	17
OTOLARYNGOLOGY	40	0	40	9	55	6	61	14
PEDIATRICS	98	29	127	25	177	49	226	53
PATHOLOGY	104	14	118	33	181	23	204	48
PATHOLOGICAL (CLINICAL) CHEMISTRY	16	2	18	0	63	5	68	12
REHABILITATION MEDICINE	8	0	8	1	30	2	32	10
PSYCHIATRY	161	1	162	40	220	9	229	55
DIAGNOSTIC RADIOLOGY	106	0	106	26	141	8	149	36
THERAPEUTIC RADIOLOGY	14	1	15	6	15	1	16	6
SURGERY	261	7	268	55	315	23	338	76
TOTALS	1,313	124	1,437	312	2,087	229	2,316	579

Numbers in brackets in Column 6 of these specialties represent the total for General Surgery and the subspecialties of Surgery that are listed in this Table and the total for Internal Medicine and the subspecialtiea of Medicine listed in this Table, respectively. Subspecialties not listed in this Table are not considered separately, i.e. they would be included under General Surgery and Internal Medicine, (unbracketed figures in Column 6).

TABLE VI

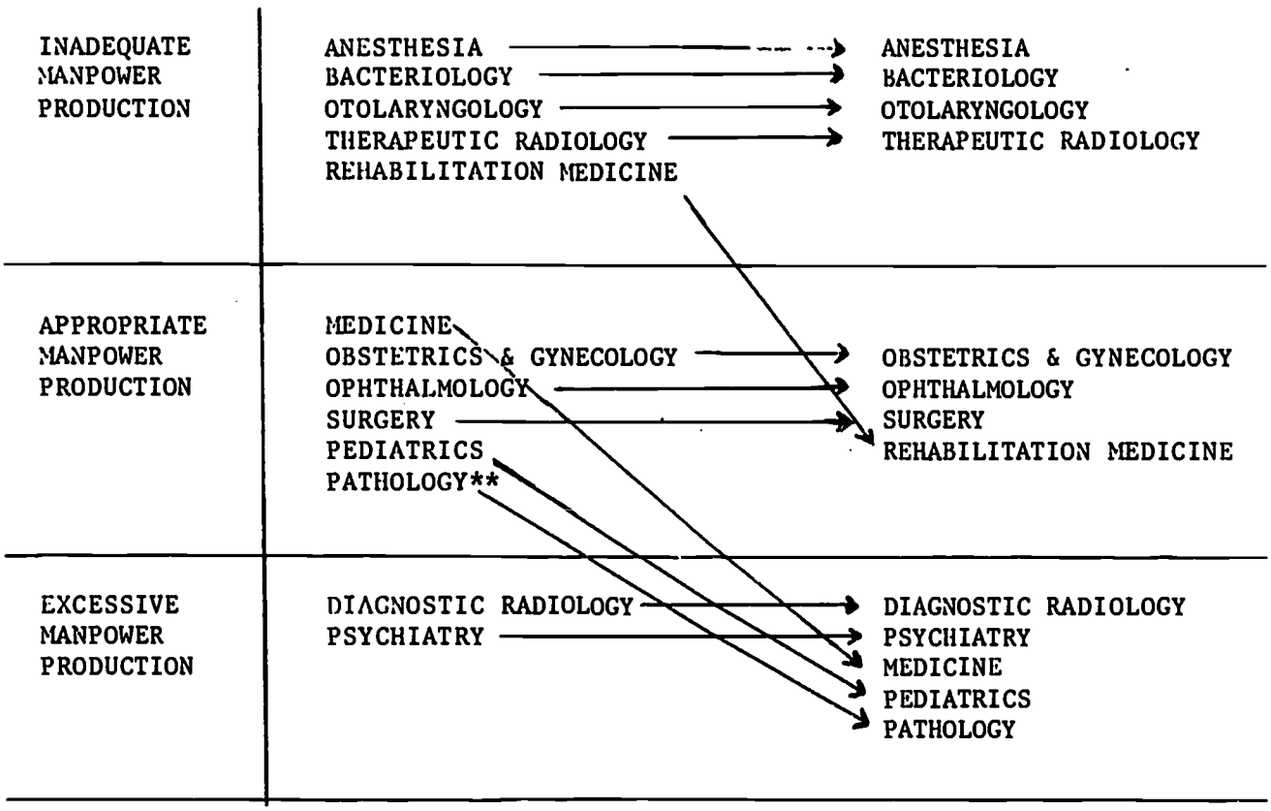
THE ROYAL COLLEGE OF PHYSICIANS AND SURGEONS OF CANADA

ANALYSIS OF SPECIALIST NEEDS, ONTARIO, JUNE 1969

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SPECIALTY	Suggested Criteria of Needs	Present Supply -Pop'n. Ratio	No. Needed On Basis of Suggested Criteria	No. Presently Available in Ontario	Estimated Current Shortage	No. required Annually to Maintain Present Supply - Pop'n. Ratio	Average No. Qualified 1968 Presently Registered in Ontario
Anesthesia	1 : 15,000	1 : 17,000	495	438	57	22	23.0
Bacteriology	1 : 100,000	1 : 142,000	74	52	22	3	.8
Cardiovascular and Thoracic Surgery	1 : 200,000	1 : 309,000	37	24	13	1	1.2
Dermatology	1 : 100,000	1 : 95,300	74	78	-	3	4
General Surgery	1 : 10,000	1 : 9,400	743	793	-	39 (59)	23
Internal Medicine	1 : 10,000	1 : 10,400	743	716	27	36 (43)	34
Neurology	1 : 125,000	1 : 125,000	59	59	-	3	3.2
Neurosurgery	1 : 125,000	1 : 240,000	59	31	28	2	1.2
Obstetrics and Gynecology	1 : 20,000	1 : 17,500	371	423	-	21	19
Ophthalmology	1 : 30,000	1 : 31,000	244	238	6	12	14
Otolaryngology	1 : 30,000	1 : 49,000	244	154	90	8	6
Orthopedic Surgery	1 : 35,000	1 : 50,100	212	148	64	7	6
Pediatrics	1 : 20,000	1 : 24,200	371	306	65	15	11.6
Pathology	1 : 25,000	1 : 35,000	297	212	85	10	14.6
Rehabilitation Medicine	1 : 150,000	1 : 339,000	50	22	28	1	1
Plastic Surgery	1 : 150,000	1 : 108,000	50	69	-	4	2
Psychiatry	1 : 15,000	1 : 15,600	495	475	20	24	32
Diagnostic Radiology	1 : 25,000	1 : 22,300	297	332	-	16	19.4
Therapeutic Radiology	1 : 100,000	1 : 212,000	74	35	39	2	1.8
Urology	1 : 50,000	1 : 59,000	149	127	22	6	6
TOTALS			5,138	4,732	566	235	223.8

T A B L E VII

TRENDS IN MANPOWER PRODUCTION IN CLINICAL SPECIALTIES:



* Adequacy or otherwise of outputs in this Table are judged entirely by comparing projected outputs from this Survey (Table V) with Analysis of Needs by Royal College of Physicians and Surgeons, 1969 (Table VI). The possibility of overproduction of manpower in four clinical specialties may not be an actuality (see comments).

** Includes Laboratory Medicine.

III SPECIALIZED MANPOWER PRODUCTION

(c) MANPOWER OUTPUT FROM THE RESIDENCY AND FELLOWSHIP TRAINING PROGRAMMES IN THE SUBSPECIALTIES OF MEDICINE, PEDIATRICS, PATHOLOGY AND SURGERY FOR THE YEARS 1970 and 1975 (TABLE VIII)

In perusing the figures in Table VIII in this section, it must be appreciated that these totals for the Province result from the adding together of figures, some of which are firm and some of which are "best guesses". Accepting this lack of hard data in some instances, the totals for each year and the planned increase in the manpower production in these disciplines from 1970 to 1975 point up several trends. (Where appropriate the subspecialty manpower output projections of this survey have been correlated with the Royal College of Physicians & Surgeons analysis of needs (see Table VI).

There would appear to be little, if any, overproduction of subspecialists in these disciplines in this Province today. In fact, there would appear to be serious underproduction of manpower in many subspecialties.

If these figures reflect what the state of subspecialty manpower production will be in 1975, the following comments seem appropriate.

Medicine: There will be a serious underproduction of oncologists, clinical pharmacologists and rheumatologists and no subspecialists will be qualifying in clinical epidemiology, genetics, geriatrics and infectious disease. In making these generalizations, however, it must be appreciated that a substantial number of general internists will have received a significant amount of subspecialty training of one type or another.

In Community Medicine* and Rehabilitation Medicine* the figures suggest we will be producing more than ten times the numbers that we are now. These projected figures are unlikely to be attained if, for no other reason, than that these fields have thus far not attracted large numbers of trainees, in spite of there being enlightened training programmes available. However, a significant but small percentage (estimated at 10-20 percent) of trainees in the specialty training programmes of Medicine, Pediatrics and Psychiatry may take only a portion of the training in these specialties and then proceed into community practice. In addition, it is worthy of note that a graduate of an Ontario Medical School may go into family practice after a rotating internship and need not take the two-year programme in Community Medicine.

Surgery: A number of people have feared an overproduction of orthopedic surgeons and neurosurgeons during the next five years. This fear might be enhanced by seeing that the output in these surgical subspecialties will approximately double over this five-year period. However, if we compare these projected outputs with the analysis of needs by the Royal

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* These disciplines are considered in this Section as subspecialties of Medicine for completeness sake, even though they were considered as individual specialties (separate from Medicine) in Section (b) of Specialized Manpower Production.

College, it would seem that we need not fear an overproduction of subspecialists in Orthopedic Surgery and Neurosurgery. In addition, it should be mentioned that changes in patterns of practice in these subspecialties (e.g. orthopedic surgeons looking after all fractures and being heavily involved in trauma units; neurosurgeons practising in smaller population centres) may also demand even further increase in manpower production in these subspecialties although such changes may not in fact be desirable.

Pediatrics: There is a serious lack or shortage of subspecialty manpower production in 1970. This situation will improve by 1975 according to the figures, but a good deal of the projected increase will come from the development of one new programme (McMaster) whose projected output in terms of manpower may not be realized.

Pathology: There is currently too little training of clinical pathologists (morphologists, clinical biochemists and microbiologists). The two Pathological Chemistry departments in this Province hope to correct the deficiency in Clinical Biochemistry by 1975, but serious deficiencies in Microbiology will remain.

Considering the ever-increasing complexity of clinical practice in any field, and the fact that this trend has been largely responsible for the development of subspecialties to the present extent, these totals for manpower production of subspecialists in 1975 would generally indicate underproduction rather than any significant overproduction.

TABLE VIII

OUTPUT IN SUBSPECIALTIES OF MEDICINE AND SURGERY

	1970	1975
GENERAL MEDICINE	37	41
Cardiovascular	4	7
Dermatology	3	5
Endocrinology + Metabolism	2	5
Gastroenterology	2	6
Hematology	2	8
Neurology	3	8
Community Medicine	10	113
Nephrology	1	3
Respirology	1	4
Rheumatology	1	2
Immunology	0	3
Rehabilitation Medicine	1	10
Cancer	1	1
Clinical Pharmacology	0	1
GENERAL SURGERY	28	36
Cardiovascular	3	4
Orthopedics	8	18
Urology	6	8
Neurosurgery	4	8
Plastic Surgery	3	4
Pediatric Surgery	3	3

OUTPUT IN SUBSPECIALTIES OF PEDIATRICS AND PATHOLOGY

	1970	1975
GENERAL PEDIATRICS	21	32
Hematology	2	2
Immunology	0	1
Respirology	1	1
Infectious Disease	1	1
Rehabilitation +Child Development	0	2
Genetics	0	1
Cardiology	2	3
Neurology	1	2
Neonatology	1	4
Endocrinology	1	3
Metabolism	0	1
GENERAL PATHOLOGY	18	25
General Anatomic Pathology	10	10
Neuropathology	2	2
Gynecological Pathology	0	0
Pediatric Pathology	1	0
CLINICAL PATHOLOGY	0	0
Hematologic Pathology	3	5
Clinical Biochemistry	0	9
Clinical Microbiology	0	4

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SECTION IV: PROVINCIAL PATTERN OF RESEARCH

IV PROVINCIAL PATTERN OF RESEARCH

(a) PROJECTED AREAS OF RESEARCH DEVELOPMENT

An attempt was made to determine which subject areas of research are definitely about to be developed and which areas are projected for possible development before 1975.

A number of factors limit the interpretation of this data:

1. Many departments do not have a co-ordinated long-term research development programme. New research areas are frequently determined by the interests and training of persons available for appointment at the time positions are vacant.

2. In some departments, the chairman was about to retire or has not been appointed. In these, the direction of activity is subject to change.

3. In many instances, plans for the future are contingent upon local decisions yet to be taken regarding priorities of space development compatible with the expected level of provincial capital funding in the next ten years.

4. The current difficulties in the funding of new research programmes may inhibit development of some of those now considered to be "definite".

5. The magnitude of proposed research development in specific areas was not studied, and could range from the creation of an institute to the appointment of single part-time investigators. It has not been possible to assign weighting factors. It is grossly misleading and serves little purpose to merely tabulate the proposed research areas when this produces no impression of magnitude of effort and resource commitment.

Lists of "Definite" and "Proposed" Subject Areas of Research are appended (Appendix C and D).

Discussion

The projections of research development gathered in this survey have many serious limitations which restrict interpretation. The outstanding features that emerge, however, are:

(a) There is a great diversity of new subject areas proposed, both basic and clinical. There is a trend towards development of new research in areas now deficient at the individual Medical Schools, centered on the work of individuals or small groups of individuals.

(b) Each Medical School appears to continue the past pattern of relative autonomy of development of research based on local recruitment, staffing and facilities; little evidence of planned major co-operative ventures was forthcoming.

(c) There is an apparent absence of plans for development of very large units directed to specific restricted objectives.

(d) There is a new emphasis on matters relating to medical and paramedical education and health care delivery.

It is currently envisioned that each Medical School with its affiliated hospitals will become the centre of a regional health complex providing health care, medical and paramedical education, and research. It is of interest to note that the research projections are consistent with this in that:

(a) The diversity of proposed research is probably indicative of a staff recruitment policy that will provide a full range of teaching and patient care in each region, and the opportunity for research by the additional faculty members.

(b) The emphasis on research in education and health care is appropriate to the regional role of the Medical Schools.

There is little evidence of "duplication" in the sense of specific large projects, although there now is, and clearly will continue to be, much overlap of broad fields of research. Specific areas under active development, such as Transplantation Sciences and Nuclear Medicine, should be carefully watched to ensure that the overlap does not become unproductive duplication.

The survey did not specifically study the financial, staffing, and space implications of the proposed research development. We do not know which of the proposed fields represent increased utilization or changes of emphasis on the part of the existing staff, and which represent the activities of new faculty members. Two large factors which will tend to inhibit development are:

(a) Capital funding proposed for the period 1970-1980 is less than requested, and spread over a longer period than initially considered; there may well be by 1975, less new research space than was previously thought at some of the Medical Schools.

(b) Funding from Medical Research Council and other government and private agencies is currently well below requested levels. New projects appear particularly difficult to fund except in those fields in which government agencies allocate money for specific purposes.

In addition, some fields (Pathology, Clinical Epidemiology, Clinical Pharmacology, etc.) are handicapped by problems of recruitment.

The survey did not evaluate the future need for large shared inter-university equipment or facilities. This should be done in the future, bearing in mind that

(a) The expense of "duplication" of such facilities must be balanced against administration costs in a central unit, the costs in lost faculty time, travel expenses, etc.

(b) Some pieces of equipment (e.g. scanning electron microscopes) might better be regarded as intra-university, interfaculty resources, thus available locally to investigators in medical and other science fields.

In summary, the pattern of proposed research development in Ontario in the next five years is one of increasing diversity as Medical Schools expand and strengthen their faculties to fulfil their roles as regional centres. It is quite possible that capital and research funding policies will tend to restrict development of research to levels below those now contemplated. There is no evidence for major planned inter-university integration of research activity and no evidence of duplication of specific large projects.

CONCLUSIONS

1. The pattern of proposed research development in the Ontario Medical Schools in the next five years is one of increasing diversity as medical schools expand and strengthen their faculties to fulfil their role as regional health centres.

2. Research planning appears to be largely based on the activities of individuals or small groups of individuals. There was little evidence provided of plans to develop very large intra-university. units directed to specific restricted objectives, or of plans for major inter-university co-operative research.

3. It seems possible that restrictions in capital and research grant funding will inhibit development of research to the levels below those now contemplated.

4. There is no evidence for duplication of projected specific large projects, although there will continue to be much overlap of general fields of research. It will be necessary to carefully evaluate certain rapidly developing fields to determine whether unproductive duplication occurs in the future.

APPENDIX C

Subject Areas of Research to be Developed by 1975 ("Definite")

Queen's University

Department	Subject Area
Anesthesia	Pharmacology: inhalation anesthesia
Biomedical Electronics	Computers - control systems, patient monitoring
Community Health & Epidemiology	Health care - delivery
Medicine	Nephrology - transport
	Hematology - coagulation
	Metabolic - uric acid
	Rheumatology - synovectomy
	Immunology - collagen disease
Obstetrics & Gynecology	Endocrinology - steroids, reproduction
Ophthalmology	Ocular fluid dynamics
	Endocrinology - diabetic retinopathy
Pathology	Respiratory pathology
	Metabolism - nucleic acids
Pharmacology	Metabolism - porphyrins
Surgery	Nervous system - blood flow & fluid dynamics
	Immunology - transplant rejection

APPENDIX C

Subject Areas of Research to be Developed by 1975 ("Definite")

University of Ottawa

Department	Subject Area
Physiology	Muscle metabolism and function
	Pineal function
	Mineral metabolism
Pharmacology	Drug metabolism
	Cardiovascular
	Enzyme induction
Histology & Embryology	Histochemistry of bone
	Histophysiology of bone
Medicine	Nephrology
	Dermatology
	Immunology
	Respiratory
Obstetrics & Gynecology	Reproductive biology
Epidemiology & Community Medicine	Cardiovascular
	Respiratory

APPENDIX C

Subject Areas of Research to be Developed by 1975 ("Definite")

University of Toronto

Department	Subject Area
Diagnostic Radiology	Vitro Microcirculation
	Ultra high speed cineangiography
	Image enhancement techniques
Therapeutic Radiology	Therapy of malignant disease
	Radiation response of tumors
Pediatrics	Immunology
	Genetics
	Community Pediatrics
	Growth & development
Anesthesia	Human respiratory physiology
	Pharmacology & pharmacogenetics
	Cardiovascular physiology
	Cerebral blood flow
	Hyperbaric med. & oxygen toxicity
	Mechanisms of pain
Obstetrics & Gynecology	Perinatology
	Myometrial physiology
	Steroid metabolism during pregnancy
	Endocrinology of reproduction
	Immunologic implications in reproduction
	Detection & treatment of early cancer
	Genetic defects in the fetus and newborn
	Maternal health care delivery
Behavioural Science	Hospital and the community
Pathology	Forensic medicine

APPENDIX C - University of Toronto (continued)

Department	Subject Area
Art	Audio Visual
Medicine	Infections and antibiotics
	In vitro activation analysis
	Clinical pharmacology
	Transplantation immunology
	Chemotherapy of cancer
	Community medicine
Pathological Chemistry	Radioimmunoassay
Physiology	Endocrinology and metabolism
	Salt and water metabolism
	Renal function
	Cardiovascular function; blood clotting
	Gastrointestinal function
	Neurophysiology, electrophysiology and special senses
	Application of mathematics to biological problems
Laboratories	Development of immunologic and biologic products
Ophthalmology	Heredity
	Optics
Medical Biophysics	Cellular immunology
	Animal virology
	Cellular differentiation
	Radiobiology
	Radiation chemistry
	Electron microscopy
	Chemotherapy

APPENDIX C - University of Toronto (continued)

Department	Subject Area
Medical Research	Metabolic control systems
	Structural and functional correlates at cell level
	Synthesis and release of hormones
Biochemistry	Structure and function of biological macromolecules
	Function and structure of biological membranes
	Enzyme structure and function, mechanisms of catalysis or control mechanism in metabolism

APPENDIX C

Subject Areas of Research to be Developed by 1975 ("Definite")

University of Western Ontario

Department	Subject Area
Several	Venous thrombosis
	Gastric secretion
	Cardiac transplantation
	Tumor growth
	Retinal vascular diseases
	Intestinal motility and absorption
	Medical care
Biochemistry	Membrane biochemistry
	Phospholipid chemistry
Physiology	Visceral brain, controls, regulations and behaviour
Pharmacology	Drug absorption
Anatomy	Cytogenetics and ultrastructure
Biophysics	Red cell membranes

APPENDIX D

Projected Subject Areas of Research that might be developed by 1975 ("Proposed")

McMaster University

Department	Subject Area
Physiology, Psychiatry, Pharmacology, Neurology	Neurobehavioural science
Medicine, Pathology, Pediatrics	Hematology
Medicine, Anesthesia, Pediatrics, Pathology	Respiratory and exercise physiology
Pathology, Surgery, Radiology, Medicine, Epidemiology	Vascular research (thrombo-embolism atherosclerosis, microvascular)
Family Medicine, Epidemiology	Health care research
Medicine, Pediatrics, Surgery, Pathology, Biochemistry	Immunology
Medicine, Surgery, Biochemistry, Pathology	Metabolism
Physiology, Pharmacology, Pathology, Medicine, Pediatrics, Anatomy, Neurobiology, Biochemistry	Cell biology (cell adhesion, cell differentiation, secretory coupling, mechanism)
Medicine, Pediatrics, Pathology	Microbiology
Biochemistry	Nucleic acids and synthesis of macromolecules

APPENDIX D

Projected Subject Areas of Research that might be developed by 1975 ("Proposed")

Queen's University

Department	Subject Area
Community Health & Epidemiology	Epidemiology
Community Medicine	Health care - urban and rural delivery Health care - regional, hospital-based
Medicine	Clinical pharmacology Infectious Diseases Respiratory Immunology - protein chemistry Neuromuscular - muscle chemistry
Obstetrics & Gynecology	Genetics - neonatal; neoplasia
Ophthalmology	Neurophysiology - retina Infectious diseases - virus Pathology (research)
Otolaryngology	Vertigo; deafness
Pediatrics	Genetics; neonatal
Pathology	Cardiovascular Forensic pathology
Pharmacology	Clinical pharmacology Autonomic pharmacology
Psychiatry	Physiologic monitoring
Therapeutic Radiology	Epidemiology - cancer
Surgery	Cardiovascular - myocardium Cardiovascular - peripheral vascular disease Musculoskeletal - gait mechanics Musculoskeletal - Perthes' Disease Neoplasia - lymphatic spread
Urology	Neoplasia - bladder, epidemiology Immunology - renal transplant
Rehabilitation Medicine	Health care - community Rheumatology - arthroscopy

APPENDIX D

Projected Subject Areas of Research that might be developed by 1975 ("Proposed")

University of Ottawa

Department	Subject Area
Pharmacology	Neuropharmacology
	Toxicology
Medicine	Rehabilitation
	Cardiovascular
	Biochemical emergencies
	Automated clinical model
Pathology	Immunology
	Neuropathology
	Gastroenterology
Anesthesia	Neuropharmacology
Epidemiology & Community Medicine	Health care

APPENDIX D

Projected Subject Areas of Research that might be developed by 1975 ("Proposed")

University of Toronto

Department	Subject Area
Therapeutic Radiology	Therapy of malignant disease - new techniques
Anesthesia	Neurophysiology of anesthesia
Hygiene	Epidemiological study of hospital and health statistics
	Water pollution
Preventive Medicine	Clinical epidemiology
	Industrial medicine
	Delivery of health care
	Socio-psychological factors in disease and disability
Obstetrics & Gynecology	Metabolism and control of malignant cells
Behavioural Science	Analysis of health services and health manpower
	The health of Indians in Northwestern Ontario
Bacteriology	Mycoplasma studies
	Antibiotic evaluations
	Direct electron microscopy
	Immunofluorescent studies
Rehabilitation Medicine	Study of regeneration of spinal cord
Art	Visual perception
Medicine	Forensic medicine and pathology
Pathological Chemistry	Vitro analytical and diagnostic uses of radionuclides
Anatomy	Immunogenetics in transplantation
Surgery	Immunology
	Bacteriology
	Fundamental aspects of cancer
	Vascular rheology
	Pulmonary studies
Ophthalmology	Physiological electronics of ocular receptors

APPENDIX D - University of Toronto (continued)

Department	Subject Area
Medical Biophysics	X-ray diffraction studies of biological molecules
Cell Biology	Physical chemistry of biological molecules
Pharmacology	Clinical pharmacology
Biochemistry	Structure and function of macromolecules
	X-ray crystallographic analysis
Medical Research	Action of hormones
	Control of protein synthesis

APPENDIX D

Projected Subject Areas of Research that might be developed by 1975 ("Proposed")

University of Western Ontario

Department	Subject Area
Several	Lipid metabolism (atherosclerosis)
	Adrenal metabolism
	Decision making in medical practice
	Audiology
	Research in communications and treatment
	Delivery and neonatal morbidity
	Rh sensitization
	Exfoliative cytology

IV PROVINCIAL PATTERN OF RESEARCH

(b) NEGLECTED AREAS OF RESEARCH

Department heads were asked to identify neglected areas of research in their departments or their university. The replies in general are applicable to the local, rather than the provincial, situation; the listings reflect in part those fields in which individual departments or Medical Schools do not presently have a specialist or group of specialists at a clinical or basic science level. The term "neglect" was not defined; the threshold of recognition of neglect has clearly been far from uniform. As well, areas of comparative neglect (or lack of development) may have been viewed in comparison with strength in those areas in other Schools, rather than from any absolute criteria.

The lists of neglected areas (Appendix E) include essentially all possible areas of basic and clinical research; as a result a simple tabulation is of limited value except to show that few if any areas are now developed in adequate depth to the satisfaction of all concerned.

Despite these limitations certain general areas occurred with high frequency in the submissions and thus probably reflect an overall provincial neglect:

1. Research into the delivery of health care; health services; provision of diagnostic services; logistical needs of regional health care; role of paramedical personnel; cost effectiveness analysis; prevention of disease.

2. Clinical pharmacology; drug metabolism; applied and basic toxicology; mechanisms of drug action; chemotherapy.

3. Behavioural sciences; growth and development; studies of motivation; addiction; learning; mental retardation; psychiatric therapy.

4. Medical education; selection of students; methods of teaching; evaluation; motivation; paramedical education.

5. Environmental pollution and toxicity; pollution control.

6. Microbiology and virology; basic genetics and physiology of micro organisms; infectious diseases; diagnosis; therapy; prevention.

7. Geriatrics; diseases of the elderly.

8. Cardiovascular research - in particular, vascular disease and its complications.

It is imperative to recognize that individual Medical Schools have identified particular areas of neglect in their setting which must be rectified to provide adequate teaching and patient care, quite apart from the overall provincial picture in those areas. Research areas which appear well developed from the provincial viewpoint are nonetheless of legitimate concern to the individual Schools in which they are deficient.

CONCLUSIONS

Although a wide range of subjects was suggested as now neglected, the general research areas most frequently emphasized were:

(a) Research in the delivery of health care and health services

(b) Clinical pharmacology and toxicology

(c) Behavioural sciences

(d) Medical and paramedical education

(e) Microbiology and infectious diseases

(f) Environmental hazards

(g) Cardiovascular disease

In general, individual Medical Schools identified areas of neglect in their individual settings which must be rectified to provide adequate teaching and patient care quite apart from the overall provincial picture in those areas. Research fields which appear well developed from the provincial viewpoint are nonetheless of legitimate concern to the individual Schools in which they are deficient.

APPENDIX E

Neglected Areas of Research

McMaster University

Subject Areas of Neglect

Health care and services research

Clinical epidemiology

Rehabilitation medicine

Psychiatric treatment

Clinical pharmacology and toxicology

Alcoholism and drug addiction

Drug metabolism

Bioengineering

Growth and development

Behaviour and learning

Reproductive biology

Microbiology

Metabolism

Oncology

Trauma

Medical education

Pollution

APPENDIX E

Neglected Areas of Research

Queen's University

Department	Subject Areas of Neglect
Microbiology	Microbial genetic and physiology
Pharmacology; Pathology	Drug metabolism and toxicity
Otolaryngology	Inner ear - physiology and pathology
Pathology	Respiratory system - pathology
Physiology	Physiology of the special senses
Medicine; Pathology	Atherosclerosis
Physiology	Gastrointestinal physiology
Medicine; Pharmacology	Clinical pharmacology
Medicine	Infectious diseases
Medicine	Geriatrics
Medicine	Dermatology
Psychiatry; Gynecology	Behavioural research
Urology	Infertility
Several	Environmental toxicity
Rehabilitation Medicine	Vocational rehabilitation
Rehabilitation Medicine	High level quadriplegic
Pediatrics	Pediatric cardiology
Pediatrics	Pediatric neurology
Pediatrics	Infectious diseases
Pediatrics	Pediatric rheumatology
Pediatrics	Pediatric allergy and immunology
Pediatrics	Pediatric hematology
Several	Genetics of disease
Several	Delivery of health care - urban and rural paramedical workers and health teams
Pathology	Laboratory systems in community medicine
Several	Logistical needs of education in health sciences
Several	Logistical needs of regional health care

APPENDIX E

Neglected Areas of Research

University of Ottawa

Department	Subject Areas of Neglect
Physiology	Neurophysiology
Microbiology and Immunology	Hospital cross infection
Pharmacology	Drug action (including toxicology)
Pharmacology; Surgery; Medicine	Immunology
Epidemiology and Community Medicine	Arteriosclerosis
Surgery	Shock
Surgery	Fluid and electrolyte metabolism
Surgery; Medicine; Pathology	Gastrointestinal function
Surgery; Medicine; Obstetrics and Gynecology	Cancer
Medicine	Dermatology
Medicine	Rehabilition
Medicine	Health care
Medicine	Psychiatry (all areas)
Medicine; Pathology	Pulmonary disease
Pathology	Nephrology
Pathology	Neuropathology
Medicine; Pharmacology	Biomedical engineering

APPENDIX E

Neglected Areas of Research

University of Toronto

Department	Subject Areas of Neglect
	Behavioural sciences - motivation
	Environment
	Nutrition
	Delivery of health care
	Microbiology - epidemiology
	infections
	antibiotic evaluation
	Clinical pharmacology and chemotherapy
	Nutrition
	Immunology
	Environmental pollution
	Toxicology
	Bacteriology

APPENDIX E

Neglected Areas of Research

University of Western Ontario

Department	Subject Areas of Neglect
Several	Immuno-chemistry
	Biochemistry of embryogenesis
	Hearing aids
	Molecular biology
	Postoperative care
	Research in medical education
	Studies of primary medical practice
	Studies of diagnostic processes
	Hematology
	Endocrinology
	Infectious diseases
	Otolaryngology
	Clinical endocrine facilities
	Mental retardation
	Pediatric cardiovascular disease
	Ultracentrifugation
	Dental care
	Cleft palate
	Cerebral palsy
	Neurohistology
	Neuropathology
	Transplantation studies
	Bacterial physiology

IV PROVINCIAL PATTERN OF RESEARCH

(c) SPECIALIZED RESEARCH FACILITIES

The Committee identified specialized research equipment ("one of a kind facilities") existing or proposed. The original intent was to identify research equipment costing over $100,000.00 but some highly specialized units have been included which do not contain individual items of equipment costing $100,000.00.

Appendix F tabulates these special facilities and/or units.

COMMENTS

The survey has not identified any major research equipment or highly specialized unit, either existing or proposed, which is duplicated. Expensive equipment (e.g. electron microscopes, radiation counting equipment) is duplicated in every Medical Faculty; these tools are so widely used in every Faculty that the Committee did not consider them to be specialized facilities as defined.

CONCLUSIONS

The survey has not identified any major research equipment or highly specialized research unit, either existing or proposed, which is duplicated in the Ontario Faculties of Medicine.

APPENDIX F

SPECIALIZED ("One of a Kind") FACILITIES BY FACULTY

SCHOOL	FACILITY	LOCATION	EXISTING (or) APPROVED AND UNDER DEVELOPMENT	OR PROPOSED
UNIVERSITY OF TORONTO	Whole Body Counter	Toronto General	Yes	---
	Hyperbaric Chamber	Toronto General	Yes	---
	Cortical Audiometry	Toronto General	Yes	---
	Vertigo Unit	Toronto General	Yes	---
	Radiology Research Inst.	/ Med. Science Building	Yes	---
	Linear Accelerator	Princess Margaret Hospital	Yes	---
	Neutron Generator	Princess Margaret Hospital	---	Yes
	Cyclotron	Department of Medicine	---	Yes
	N.M.R.	Sheridan Park	---	Yes (McMaster & Toronto)
	Analytical Pharmacology Laboratory	// Med. Science Building	Yes	---

/ Equipment Includes:

X-ray sensitive Vidicon with secondary magnification apparatus (microangiology)
High speed biplane cineangiography apparatus.

// Equipment Includes:

Cary Spectrophotometer. Zeiss Spectrophotometer Flueorimeter.
Atomic Absorption Spectrometer. Scintillation Counter - 6 channel.
Gas Chromatograph with Integrator and Recorder.
Electron Spin Resonance Equipment.

APPENDIX F

SPECIALIZED ("One of a Kind") FACILITIES BY FACULTY

SCHOOL	FACILITY	LOCATION	EXISTING (or) APPROVED AND UNDER DEVELOPMENT	OR PROPOSED
McMASTER UNIVERSITY	High Resolution Mass Spectroscope	Depts. of Chemistry & Biochemistry	Yes	---
	N.M.R.	Sheridan Park	---	Yes (McMaster & Toronto)
	Nuclear Reactor-Linear Accelerator	Campus	Yes	---
QUEEN'S UNIVERSITY	E.C.G. Data Acquisition & Computer Analysis	Dept. of Medicine	Yes	---
	Ultrasonic Recording (Intracranial Interfaces)	Dept. of Medicine	Yes	---
UNIVERSITY OF OTTAWA	Frozen Blood Storage Facility	National Defence Med. Centre	Yes	---
UNIVERSITY OF WESTERN ONTARIO	Gnotobiotic Unit	Dept. of Bacteriology	---	Yes
	Gamma Cell Sterilizer	University Hospital	Yes	---

IV PROVINCIAL PATTERN OF RESEARCH

(d) INTER-UNIVERSITY CO-OPERATIVE PROGRAMMES

Shared Support Services

The Committee could not find any existing support services which are shared by two or more Ontario Medical Faculties.

The Committee considered that shared support for the development of an experimental animal resource centre is an urgent requirement. Consideration also should be given to the future course of development of medical libraries (e.g. the advisability of binding and storing vast numbers of periodicals, the relationship of the libraries to the proposed National Library of Science and Health Sciences). In the areas of audio visual services and computer programming close liaison should exist between the Schools to ensure that: a) equipment selection is standardized, and b) that the audio visual centre of each University (or Faculty) has information on material available and projected undertaking in other Faculties of Medicine.

Training Programmes

Inter-university co-operative programmes of a formal nature are attached (Table IX). The subcommittee did not explore the details of these programmes, but from our knowledge of them, they are limited in scope (e.g. an arrangement to have one individual spend a portion of their training period in another institution). No major co-operative training programmes comparable to those which exist in the clinical fields among multiple affiliated hospitals of a Faculty seem to exist between two or more university departments of the Ontario Faculties of Medicine. Several are under consideration.

Research

Research co-operation exists between groups or individuals in Ontario Medical Faculties and other institutions (see Table X). No attempt has been made to explore the extent of these collaborative efforts; it is known that a number of them are superficial and involve little more than an interchange of ideas and information between individuals or groups with a mutual interest. The level of research co-operation in the sense of collaborative design and execution of major projects is low.

The co-operative cancer therapeutic programmes fostered by the Ontario Cancer Foundation clinics are an exception to this statement.

CONCLUSIONS

1. No examples of share support service were found. The Committee considered that development of shared support services in some areas is desirable, e.g. an experimental animal resource centre.

2. Inter-university co-operative training programmes are limited, but several are under consideration.

3. There is good evidence of research collaboration in a few specific areas, notably in the therapy of malignant disease.

TABLE IX

EXISTING INTER-UNIVERSITY CO-OPERATIVE TRAINING PROGRAMMES

Discipline	Universities Participating
Preventive Medicine	Toronto - University of West Indies
Therapeutic Radiology	Toronto - Queen's
Art as Applied to Medicine	Toronto - Ann Arbor
Surgery (Plastic)	Toronto - Manitoba
Otolaryngology	Toronto - McGill - Montreal
Pharmacology	Toronto - Western
Medicine	Western - Tufts
Obstetrics and Gynecology	Western - McMaster

TABLE X

EXISTING INTER-UNIVERSITY CO-OPERATIVE RESEARCH PROJECTS

Discipline or Subject Area	Participating Institutions
Neuroanatomy - basal ganglia	Ottawa - Albert Einstein
Neurobiology	Ottawa - Columbia
Histophysiology - Histochemistry of hard tissue	Ottawa - Columbia
Cancer of Lung - Therapy	Toronto - Ottawa - Western
Pediatrics - Chemotherapy of malignant tumors	Toronto - Multiple Groups (U.S. & Can.)
Hodgkins Disease - Radiotherapy	Toronto - Multiple Groups (U.S.)
Medicine - Gastroenterology esophageal tumors	Queen's - Toronto
Medicine - Metabolism - Vitamin D	Queen's - Wisconsin - Mayo Clinic
Pediatrics - Genetics	Queen's - Toronto
Pharmacology - Drug Toxicity	Queen's - Food and Drug
Therapeutic Radiology, Neoplasia - Breast Cancer	Western - Queen's
Urology - Neoplasia - Bladder Cancer	Queen's - Columbia
Neuroanatomy - Amygdala	Ottawa - Oslo University - Aarhus University
Medicine - Respirology	McMaster - Manitoba - McGill
Pathology - Thromboembolism	McMaster - Toronto
Anatomy - Neurophysiology - microwaves	Queen's - National Research Council
Medicine - Endocrinology - steroids	Queen's - Toronto
Medicine - Endocrinology - steroids	Queen's - McGill
Medicine - Hematology - Chemotherapy	Queen's - Toronto
Pediatrics - Gastroenterology - Absorption	Toronto - Guelph
Pediatrics - Metabolism - Amino Acid Transport	Toronto - McGill
Pathology	Toronto - Milan
Otolaryngology - motion sickness	Toronto - University of Florida

IV PROVINCIAL PATTERN OF RESEARCH

(e) RESEARCH CO-ORDINATION

The problem of research co-ordination and management is one which we are now faced with in respect to priorities in health research and use of resources. There are needs at both the University and Government levels which make it important to provide solutions in this area. At the present moment research management and co-ordination in the Ontario Medical Schools is as follows:

McMASTER UNIVERSITY	Research co-ordination in respect to - physical resources and equipment - research priorities
QUEEN'S UNIVERSITY	Faculty - administrative co-ordination regarding grant requests and equipment. Senate Committee - to examine question of research co-ordination.
UNIVERSITY OF OTTAWA	No formal mechanisms
UNIVERSITY OF TORONTO	No formal mechanisms
UNIVERSITY OF WESTERN ONTARIO	No formal mechanisms

CONCLUSIONS

There are no existing programmes for the complete co-ordination of health research activities within the Faculties of Medicine in Ontario, although one school has established a fairly broad programme. Subsequent to the receipt of the information for this report two additional Faculties of Medicine have initiated mechanisms for research co-ordination.

The committee recognizes the need for careful co-ordination of health research in Ontario, within each Faculty of Medicine, among the other University departments which have related activities, and among the five Health Sciences Centres in the province. Such co-ordination should ensure the effective use of resources, preserve the initiative of individual scientists, and maintain flexible and effective programmes in health research.

Some thoughts concerning co-ordination of health research are given in Appendix G.

APPENDIX G

PRIORITIES IN HEALTH RESEARCH AND RESEARCH CO-ORDINATION

It is necessary today to try and decide what the priorities in research should be; the main point of view is that all research, including medical research should be directed towards specific goals. Such a concept shows a lack of understanding of what constitutes the research process. Good research in all fields has always depended upon, and will depend upon, the initiative, imagination, integrity and energy of trained competent investigators. External agencies cannot direct a good research programme. However, they can suggest areas of research which are important in terms of the agencies' objectives and the needs of society. An external agency can influence the course of research by influencing the resources, and the environment in which research is carried out.

While it is difficult to accept the concept of research directed by external agencies, it is equally difficult to accept the concept that the investigator should be left "to do his own thing" in isolation. Thus, today society which provides the bulk of the support for research can justifiably ask that a research programme can be shown to have relevance to problems that exist in society. This does not mean that the work has to be relevant in the sense that it will solve a major health problem in the next six months. For example, a scientist could be studying the structure and function of the membrane of polymorphonuclear leukocytes. This is basic biological research concerned with the structure and function of membranes. It is not too difficult to illustrate the relevance of this fundamental work to basic problems in the reaction of cells, tissues and organs to environmental stimuli, one of which is injury.

The relationship among research, education and service is also of considerable importance. Good research programmes affect the quality of undergraduate, graduate and postgraduate education. It is difficult to apply new knowledge unless there are competent individuals in the region, engaged in research in the appropriate areas. Good service programmes generate problems that need to be assessed. In addition, there is a need for health research to examine the value of health care programmes.

The above points are all important in considering the question of priorities in health research. Since funds and manpower are limited it is clearly apparent that one must make certain decisions about the areas of health research with which we are to be engaged and about the grouping of these resources. Certain broad policies can be defined. It would seem sensible, for example, to identify "research programmes" in biomedical and health research. These programmes would represent

areas of intellectual activity of individuals in a number of departments. Such programmes cannot be directed but they can be co-ordinated by a senior individual or individuals. The object of co-ordination should be to achieve communication among the various individuals and groups, encourage effective use of equipment and manpower, and a periodic review of the direction and effectiveness of the programmes. The programmes should include the individuals working at a fundamental level as well as those working at a more applied and clinical level. Such programmes could have an enormous influence on the quality of health care, medical education and, of course, graduate education. Furthermore, broadly based programmes allow considerable flexibility for the investigator to change direction as new developments occur. These considerations do not exclude the possibility of initiating a new research line which promises to develop into a completely new or needed programme, when that research is identified in the person of a gifted and available scientist. Such ventures are usually initiated by individuals. There should, therefore, be some opportunity for individuals who are not clearly identified with a programme.

If the concept of "research programmes" is developed it should be possible to establish priorities in terms of recruitment of staff, the development of research space and the purchase of equipment. To make such programmes effective it will be necessary to have some form of co-ordination. One way of doing this would be to appoint a co-ordinator for each programme who would be responsible for the development and the interaction of the group and a continuing review of the objectives and achievement of each programme. He should also be able to identify the needs and priorities for each programme. This would ensure the effective use of limited resources, preserve the rights of the individual scientist and more effectively allow the justification for the provision of funds for health research.

Within such a framework as this it might also be possible to achieve inter-university co-ordination in health research as well as integration with government and community programmes.

V SUMMARY OF CONCLUSIONS

INVENTORY OF RESEARCH PROJECTS AND FINANCIAL SUPPORT

1. There appear to be more individuals engaged in some form of "clinical" research than there are in "basic" areas although the total expenditure as grants-in-aid to the "basic" side closely approximates that to the "clinical" research.

2. The data reveal obvious disparities in the funding of research in the various Medical Schools. The amount of research carried on by a particular School does not seem to be directly tied to the number of undergraduate students. Factors such as the age of the School, the size of the associated University and perhaps the character and size of the Medical School may be determining factors in this difference.

3. Detailed review of the data on the basis of individual titles has revealed negligible duplication of effort amongst the Medical Schools of the Province.

4. Detailed review also shows that while there are undoubtedly efforts at interdisciplinary study the amount of this potentially fruitful activity remains comparatively small. The prevailing pattern within defined fields of research is one of diversity of interest rather than concentration of effort on one subject area.

5. The mean operating cost per investigator in the form of grants-in-aid varies considerably from one field of research to another but nonetheless a figure of $20,000. per investigator per annum seems a reasonable average figure for the year 1969.

SPECIALIZED MANPOWER PRODUCTION

6. Graduate Degree Programmes: If enrolment predictions are realized, and manpower utilization patterns do not change, serious overproduction of M.Sc and Ph.D manpower by 1975 appears likely to occur in Biochemistry and probably also in Physiology. Manpower overproduction may occur in several other graduate degree programmes to a lesser extent.

Serious underproduction of M.Sc and Ph.D manpower in Bacteriology, Biomedical Engineering, Epidemiology and Community Health and Pathology is evident at present and will persist to 1975 and beyond.

7. Clinical Specialties: Manpower production in the specialties of Anesthesia, Clinical Bacteriology, Community Medicine, Otolaryngology and Therapeutic Radiology is decidely inadequate in 1970 and will remain so in 1975. The predicted deficit of manpower production in the specialty of Community Medicine will occur in spite of a dramatic tenfold increase in projected output during the period 1970-75. This predicted deficit will be offset at least in part by individuals who pursue courses of training other than formally designated programmes in Community Medicine.

8. Subspecialties of Medicine, Pediatrics, Pathology and Surgery: Manpower production is distinctly inadequate in 1970 in many of the subspecialties of these disciplines and will remain so in 1975.

When considered in relation to the needs for subspecialty services there does not appear to be any danger of manpower overproduction in 1970 or 1975.

PROVINCIAL PATTERN OF RESEARCH

9. The pattern of proposed research development in the Ontario Medical Schools in the next five years is one of increasing diversity as Medical Schools expand and strengthen their faculties to fulfil their role as regional health centres.

10. Research planning appears to be largely based on the activities of individuals or small groups of individuals. There was little evidence provided of plans to develop very large intra-university units directed to specific restricted objectives or of plans for major inter-university co-operative research.

11. It seems possible that restrictions in capital and research grant funding will inhibit development of research to levels below those now contemplated.

12. There is no evidence for duplication of projected specific large projects, although there will continue to be much overlap of general fields of research. It will be necessary to carefully evaluate certain rapidly developing fields to determine whether unproductive duplication may occur in the future.

13. Although a wide range of subjects was suggested as now neglected, the general research areas most frequently emphasized were:

(a) Research in the delivery of health care and health services

(b) Clinical pharmacology and toxicology

(c) Behavioural sciences

(d) Medical and paramedical education

(e) Microbiology and infectious diseases

(f) Environmental hazards

(g) Cardiovascular disease

14. In general, individual Medical Schools identified areas of neglect in their individual settings which must be rectified to provide adequate teaching and patient care quite apart from the overall provincial picture in those areas. Research fields which appear well developed from the provincial viewpoint are nonetheless of legitimate concern to the individual Schools in which they are deficient.

15. The survey has not identified any major research equipment or highly specialized research unit, either existing or proposed, which is duplicated in the Ontario Faculties of Medicine.

16. No examples of shared support services were found. The Committee considers that development of shared support services in some areas is desirable, e.g. an experimental animal resource centre.

17. Inter-university co-operative training programmes are limited but several are under consideration.

18. There is good evidence of research collaboration in a few specific areas, notably in the therapy of malignant disease.

19. Although there has been little attempt to co-ordinate research activity to date, the need for establishment of priorities, avoidance of duplication and effective use of limited resources is now recognized as an important requirement for each Faculty of Medicine individually, and for the five Faculties as a group.

END