








Economic Impact Study of
the Ontario Veterinary
College at the University of
Guelph
Final Report

July 9, 2014



Our **client service principles** are the framework we use to deliver **client service excellence**.

We will:

-  **make** and meet our commitments to you
-  **understand** your business and what is important to you
-  **provide** value and build trust through technical competence and consistent results
-  **demonstrate** professionalism through effective interaction and communications
-  provide a **no surprises** experience

We invite you to assess our performance against

Table of Contents

Table of Contents	iii
Executive Summary	1
Local Economic Impact of OVC Operations	1
Additional Economic Impact	1
Impact of Health Management Activities & Research and Innovation by OVC	1
Short and Long-Term Veterinary Medicine Needs	2
1. Objectives and Approach of the Study	3
Objectives	3
Approach and Methodology	3
Local Economic Impact of OVC operations	3
Additional Economic Impacts	3
Impact of Health Management Activities & Research and Innovation at OVC	4
Short and Long-Term Veterinary Medicine Needs	4
Structure of the Report	4
2. Economic Impact of OVC Operations	5
Economic Impact	5
Economic Impact Defined	5
Nature of Economic Impacts Evaluated	5
Approach and Methodology	6
Impact Analysis	9
Summary of Economic Impact	10
Leveraging Public Funds	10
3. Additional Economic Impacts	12
Clinical Practice of Veterinary Medicine in Ontario	12
Overall Economic Impacts of Private Practices in Ontario	14
Veterinarian Support of Critical Food Animal Industries	14
4. Impact of Health Management Activities & Research and Innovation at OVC	16
Food Animal Health Management: Safeguarding Billions in Economic Activity	16
Food Animal Health Management in Industry	16
Food Animal Health Management at OVC	16

Teaching	16
Research	16
Knowledge Transfer	17
OVC's Impact on Food Animal Health Management.....	17
Examples of OVC Impact.....	18
Conclusion	20
Public Health and Zoonoses - Educating and Protecting the People of Ontario from Animal Transmitted Diseases	21
OVC: A Critical Component in Public Health and Zoonoses Research and Practice	21
Monitoring & Collaboration.....	22
Communication to veterinarians and physicians	23
OVC in Public Health: Illustrative Examples of Research and Practice	24
Walkerton	24
Clostridium Difficile.....	24
Antimicrobial Resistance	24
Conclusion	24
Translational Medicine: Studying Naturally-Occurring Diseases in Animals to Improve the Health of People and Animals.....	26
Translational Medicine.....	26
Translational Medicine - Current Research.....	26
University of Guelph Institute for Comparative Cancer Investigation	26
Epilepsy.....	28
Obesity	28
Conclusion	28
5. Short and Long Term Veterinary Medicine Needs.....	29
Veterinary Employment Statistics	29
Geographical Distribution.....	29
Employment	30
Summary	30
6. Conclusion	31
Appendix A - Industry Background	33
Veterinary Medicine.....	33
Food Animal Production Industry Overview.....	33
Companion Animals and Equine.....	33

Public Health	34
Impact of Animals in Society	34
Appendix B - Ontario Veterinary College	36
History	36
Current State	36
Doctor of Veterinary Medicine	36
Jointly Offered Programs and Graduate Studies	36
Funding	37
Academic Departments	37
Biomedical Science	37
Clinical Studies	37
Pathobiology	37
Population Medicine	37
Initiatives	37
Centre for Public Health and Zoonoses	37
Institute for Comparative Cancer Investigation	38
OVC Pet Trust Fund	38
Campbell Centre for the Study of Animal Welfare	38
Appendix C - Interviews Conducted	39
Ontario Veterinary College	39
External	39

Executive Summary

The Ontario Veterinary College (“the OVC” or “the College”) is a hub for veterinary medicine in Ontario, and is engaged across all aspects of the food animal, companion animal, equine and public health sectors through its students, faculty and graduates. The impact it exerts is the result of the supply of highly trained veterinarians it graduates, the output and dissemination of relevant new research to continually assist industry, and the provision of clinical expertise and education to veterinarians and the public.

The OVC supports, through its research, faculty and graduates, industries that generate an estimated \$20 billion annually and directly contributes more than \$125 million to Ontario’s economy. As the only veterinary college in Ontario and one of only five in Canada, the OVC graduates almost one-third of all Canadian-educated veterinarians and the majority of these veterinarians stay in Ontario. Many of them establish private businesses that are estimated in this study to produce an annual economic impact of approximately \$1.3 billion in Ontario

Without the OVC it is doubtful that societal needs for veterinary services in the Province could be met. This is due to a number of factors including the limited capacity to educate veterinarians in Canada and the high employment levels for veterinarians.

In addition to training veterinarians, OVC plays a critical role developing and disseminating new research to industry and is a vital link in the public health community ensuring health issues are tackled from both a human and animal perspective.

The findings below outline the importance of the OVC to Ontario by highlighting not only the OVC’s direct economic contributions but also its key role in supporting the various industries in which veterinary medicine interacts.

Local Economic Impact of OVC Operations

Based upon the direct spending that is undertaken by OVC, the College creates economic activity exceeding \$125 million per year and is responsible for creating more than \$43.6 million in total employment income and 800 jobs in Ontario.

In 2013-2014, the College’s total revenue was \$63.4 million, of which only \$34.4 million of which was from government-provided operating grants. This leveraging of government funding from other revenue sources contributes significantly to the total economic impact of the College on the Province.

Additional Economic Impact

Clinical Practice of Veterinary Medicine in Ontario

The College produces the majority of veterinarians in the Province and these graduates contribute significantly to the Province’s economy. A significant portion of veterinarians operate practices, which are small businesses and have their own economic impacts. We estimated that the economic impacts associated with these practices are approximately \$1.3 billion per year while supporting more than 7,000 jobs annually in Ontario.

Veterinary Support of Critical Food Production Industries

The food animal production industry sees about \$5 billion in farm receipts and contributes an estimated \$20 billion to the provincial economy. Veterinarians play a significant role in the food animal production sector by ensuring it is meeting regulatory standards, safeguarding against losses from disease, ensuring the production of safe food and providing essential veterinarian services.

Impact of Health Management Activities & Research and Innovation by OVC

The following highlights the impact of the health management activities as well as the research and innovation at OVC.

Food Animal Health Management

Food animal veterinarians in clinical practice, industry and government in Ontario are responsible for the health of more than 218 million dairy cows, swine and poultry and the industry contributes approximately \$20 billion in economic activity to the provincial economy on an annual basis. The OVC, as one of the largest and most well respected programs of its kind in the world, is an essential link in the development and maintenance of health management standards and protocols in an ever-evolving scientific landscape. Furthermore, the continued efforts and reputation of OVC and its practicing graduates in Ontario act to reassure the public that their food will continue to be safe.

Public Health and Zoonoses

The continuum that exists between animal and human health is of major importance to the health and safety of Ontario's inhabitants, both human and animal, and it is essential that issues be tackled from both the human perspective and the animal perspective. The OVC plays a key role in helping local, provincial and federal public health organizations protect human health through investigation of zoonotic pathogens and the diseases they cause, research into the prevention and control of those diseases, and development and implementation of management techniques to prevent outbreaks. By close collaboration with the public health sector and government agencies, OVC plays a critical role in keeping the people and animals of Ontario healthy.

Translational Medicine

Translational medicine improves the health of individuals by "translating" or building on findings from naturally occurring disease in animals to develop new therapies or medical procedures in people. The College has capitalized on its position as a provincial and national hub for disease prevention, complex care and disease research, to make significant contributions to translational medicine benefitting both human and animal health. The OVC has a catchment area of several million people and their animals providing an excellent opportunity to advance discovery through studies and clinical trials into diseases common to both people and animals. By investigating naturally-occurring diseases in animals, researchers at the OVC, and its partner organizations, can assess diagnostic and therapeutic options that may be applicable to the same disease in people.

Short and Long-Term Veterinary Medicine Needs

There is almost no unemployment for veterinarians and a recent government of Canada outlook for the profession shows a projected growth in demand for veterinarians in the future¹. Add to this the fact that the scope of services provided by veterinary medicine is continually expanding, with more veterinarians providing their expertise to the public health field and other areas, and it becomes clear that the importance of veterinary medicine in Ontario and across Canada will continue to grow in the future.

¹ http://www.servicecanada.gc.ca/eng/qc/job_futures/statistics/3114.shtml

1. Objectives and Approach of the Study

Objectives

The Ontario Veterinary College (“OVC” or “College”) is a hub for veterinary medicine in Ontario, and is engaged in all aspects of the food animal, companion animal, equine and public health sectors through its students, graduates and faculty. The OVC engaged Deloitte LLP (“Deloitte”) to conduct an analysis that looks at the following areas:

- The local economic impact of OVC operations;
- The economic and socio-economic impact as a result of the clinical practice of veterinary medicine in Ontario;
- The economic and socio-economic impact of non-clinical activities and the research and innovation at OVC; and
- A forecast of short and long-term needs for veterinary medicine in Ontario.

Approach and Methodology

Local Economic Impact of OVC operations

Deloitte modeled the economic impact of the College on the Ontario provincial economy and as part of this, all OVC expenditure data used as inputs to the study was assumed to be 100% sourced from within the province; put another way, OVC was assumed to hire its production inputs from only firms located within Ontario. The multipliers considered for the analysis came from Statistics Canada² and from IMPLAN,³ however only Statistics Canada multipliers were used for the final analysis. Deloitte considered multipliers from the two sources, owing to the lack of Statistics Canada multipliers for defined tax rate and savings rates that would be observed following disbursement of payroll expenditures, and before corresponding household consumption resulting from disposable income received from these payroll expenditures. While the IMPLAN software includes assumed savings and tax rates, we found that our analysis per the assumptions used in conjunction with the Statistics Canada multipliers resulted in a total output impact figure within approximately 1% of the amount that would have been reported if IMPLAN were to have been used instead. In other words, Deloitte confirmed that our assumed savings and tax rates in supplementing the Statistics Canada multipliers were within close range of these rates as defined within the IMPLAN software.

Additional Economic Impacts

Clinical Practice of Veterinary Medicine in Ontario

Deloitte obtained data on average operating costs of a practice and determined the economic impact of an average practice.

Veterinary Support of Critical Industries

Deloitte reviewed Statistics Canada GDP data for select industries to determine the value of economic activity that relates to animal food production to illustrate the importance of veterinarian services to the broader economy.

² Specifically, Deloitte used the 2010 Provincial Input-Output Multipliers for Ontario, both Summary and Detailed Industry Aggregation, referenced by Statistics Canada under catalog number 15F0046XDB.

³ Deloitte sourced data from the 2009 IMPLAN Provincial Totals File For Ontario.

Impact of Health Management Activities & Research and Innovation at OVC

In order to highlight the impact of the key health management activities associated with the OVC and its graduates and the key research and innovation that is conducted at the College and by its faculty, Deloitte developed three case studies, chosen based on discussion with faculty at the OVC as well as with industry leaders (See Appendix C for a summary of interviews undertaken). Each case study provides an overview of a practice or activity that the College is substantially involved with in Ontario, discusses the impact that OVC's operations have on that activity and also provides several examples of research or other work that the OVC has conducted to further highlight the OVC's importance to that area. The case studies that were selected from among many possible examples include:

- Food Animal Health Management;
- Public Health and Zoonoses; and
- Translational Medicine.

Short and Long-Term Veterinary Medicine Needs

Deloitte utilised a supply and demand approach to develop this analysis by reviewing the output from the five veterinary colleges across Canada, as well as an employment trend data, to develop a broad understanding of the veterinary medicine employment landscape. As part of this process, we were able to analyze OVC's contributions against those of the four other veterinary colleges across Canada, as well as the significance of having an Ontario-based veterinary college to ensuring that Ontario's veterinary medicine needs are met now and in the future.

Structure of the Report

The report is structured to align with the areas of analysis as outlined by the OVC. The sections are as follows:

- Section 2 - Local Economic Impact of OVC Operations: This section analyses the local economic impact of OVC operations
- Section 3 - Additional Economic Impact: This section analyses the economic and socio-economic impact as a result of the clinical practice of veterinary medicine in Ontario as well as veterinary support of critical industries in Ontario
- Section 4 – Impact of Health Management Activities & Research and Innovation at OVC: This section contains the three selected case studies intended to highlight the impact of the key health management activities associated with the OVC and its graduates and the key research and innovation that is conducted at the College and by its faculty
- Section 5 – Short and Long-term Veterinary Needs: This section looks at the supply and demand relationship for veterinarians in Ontario and across Canada and examines how OVC is associated with this relationship.

2. Economic Impact of OVC Operations

Economic Impact

In this section we will examine economic impacts from a number of different views. We examined the economic impact of the College's operations in the broader economy. The College is a significant generator of economic activity from its operational and capital expenditures. Given that the College produces the vast majority of the veterinarians in the Province, the impact of their graduates is also important in assessing the overall impact of the OVC. We also wanted to take a broader look at the role veterinarians played in the broader economy. To look at this broader view we examined two items. First, we reviewed the economic impact of veterinary practices in Ontario. Second, we looked at the economic activity on a macro level of food animal production industries in Ontario. The following summarizes the three economic impacts we reviewed:

- 1) **OVC Operations:** This relates to the economic impact generated through the College's operations and also the economic impact related to the capital expenditures at the College.
- 2) **Veterinary Practices:** We looked at the resultant economic impacts that veterinarian practices in the Province of Ontario are estimated to be responsible for.
- 3) **Associated Animal Industries:** We looked at the economic activity of the industries that veterinarians perform critical functions for.

Economic Impact Defined

Economic impacts are generally defined as changes to an economy as a result of a development, undertaking or activity. As such, economic impacts measure changes in the size and structure of a jurisdiction's economy when goods and services are purchased using money generated from outside a region, or as the result of an infusion of capital for the construction of a new facility or service. Almost all activities can generate economic impact; however in its strictest sense, activities and expenditures, which result in "new" spending, are the types of activities that have the greatest *incremental impact*, and which local officials most greatly desire.

In evaluating and quantifying the economic impact of a facility, service, program offering, etc., three types of impacts are typically reviewed, Direct Economic Impacts, Indirect Economic Impacts, and Induced Economic Impacts, which we define as follows:

Direct Economic Impacts: The total expenditures on goods and services, including wages and salaries, for the construction of a proposed development, the operations of a facility or service, the staging of an event, etc.

Indirect Economic Impacts: The purchase of goods and services needed to produce the goods and services that are directly purchased in support of the construction of the proposed facility, the operation of that facility or service, the staging of the event, etc. Indirect impacts therefore measure the magnitude of interactions with other businesses, which supply the necessary materials and services, which lead to indirect demand for goods and services from other industries.

Induced Economic Impact: The impact of personal expenditures by people who have been paid wages and salaries for the production of sector/sub-sector goods and services (both direct and indirect).

Nature of Economic Impacts Evaluated

We have calculated the economic impacts (direct, indirect and induced) for each of three types of economic impact categories, namely spending impacts, employment impacts and income impacts, which are defined below:

- **Spending Impact:** the impacts resulting from the purchase of goods and services;
- **Employment Impacts:** the increases in annualized employment resulting from the purchase of goods and services; and
- **Income Impacts:** the increases in personal income resulting from increases in employment.

In some cases we will also highlight the potential tax impacts, which define the total tax (HST or Income Tax) generated from the various activities.

Approach and Methodology

We modeled economic impact of the College on the Ontario provincial economy. Additionally, all OVC expenditure data used as inputs to the study was assumed to be 100% sourced from within the Province; put another way, the OVC was assumed to hire its production inputs from only firms located within Ontario.

Multipliers considered for the analysis came from Statistics Canada⁴ and from IMPLAN,⁵ however only Statistics Canada multipliers were used for the final analysis. We considered multipliers from the two sources, owing to the lack within the Statistics Canada multipliers of defined tax rate and savings rates that would be observed following disbursement of payroll expenditures, and before corresponding household consumption on disposable income received from these payroll expenditures. While the IMPLAN software includes assumed savings and tax rates, we found that our analysis per the assumptions used in conjunction with the Statistics Canada multipliers resulted in a total output impact figure within approximately 1% of the amount that would have been reported if IMPLAN were to have been used instead. Put another way, we confirmed that our assumed savings and tax rates in supplementing the Statistics Canada multipliers were within close range of these rates as defined within the IMPLAN software.

The following OVC provided source data were utilized as inputs for the economic impact calculations:

Table 1: Client Data Sources

Item	Economic Measure
Capital expenditures from fiscal 2008/09 to 2012/13 Fiscal	All
Operating expenditures from fiscal 2008/09 to 2012/13	All except Direct Employment Effects
Human Resource data (Labour Costs and FTE data)	Direct Employment Impacts

In order to calculate the impacts, we followed the following steps.

First, we observed that the OVC data worksheets noted above contained both expenditures on goods and services, as well as payroll expenditures that OVC provided to its employees. Within the Statistics Canada model, multipliers are defined for industries producing final goods and services, but are not provided for payroll or government expenditures.⁶ Since the Statistics Canada multipliers do not include a multiplier for payroll expenditures; we were required to make supplementary assumptions regarding savings and tax rates following salary payments to OVC employees, as well as spending patterns by industry for the proportion of disposable income representing consumption expenditures made by employee households, in order to correctly estimate the economic impact of salary expenditures via our financial modelling. These supplementary assumptions are outlined below.

⁴ Specifically, we used the 2010 Provincial Input-Output Multipliers for Ontario, both Summary and Detailed Industry Aggregation, referenced by Statistics Canada under catalog number 15F0046XDB.

⁵ We sourced data from the 2009 IMPLAN Provincial Totals File For Ontario.

⁶ In the source data behind the Statistics Canada economic multipliers, industries produce commodities for other industries and sell final products to consumers. However, households making consumption expenditures following payroll receipts, and governments making final goods expenditures following tax receipts, are different. Governments and households make expenditures representing a portion of final demand, but they do not produce final goods and services, as do industries. As such, the treatment of these institutions within economic impact multipliers varies, depending upon the economic multiplier model used.

Next, we assigned each line item on the OVC provided worksheets listed above to an economic sector associated with the Statistics Canada multipliers indicated previously. We calculated three types of impacts from the OVC data: Industry Impacts, Personnel Salary Impacts and Tax Impacts. Depending on whether the line item described OVC purchases of goods or services versus payroll expenditures to employees, each line item on the OVC input spreadsheets represented either an Industry Impact or a Salary Impact. For Industry Impacts, this corresponded to the final goods and services produced by the industry described in the line item on the OVC spreadsheets. For Salary or Tax Impacts, we used our savings and tax rate assumptions as noted below.

Finally, we summarized impacts for reporting purposes and discounted impact dollars observed over time. Steps performed to calculate each type of impact are noted below. Impacts reported in each worksheet of our output deliverable are noted in Table 4 below; each worksheet includes Fiscal/Tax Impacts as well.

Table 2: Impacts Reported Within Each Deliverable Worksheet

Worksheet	Impacts Reported
Capital Expenditures	Industry Impacts
Operating Expenditures, Including Personnel	Industry Impacts and Salary Impacts
Operating Expenditures, Excluding Personnel	Industry Impacts
Personnel Expenditures	Salary Impacts

Calculating Industry Impacts

We have calculated the impacts of OVC expenditures on goods and services by assigning each OVC item to a sector from the Statistics Canada multipliers, from the Detailed Industry Aggregation (containing 234 sectors),⁷ then aggregating the input data for reporting purposes by sector and by data year, for the reported items noted in the leftmost column of Figure 1 above.

Salary/Payroll Impacts

We used a two-step process to calculate the salary and tax impacts, using Statistics Canada data along with supplementary assumptions.

In our first step, we estimated the proportion of salary expenditures (pre-income tax) paid by OVC to its employees that represented consumption expenditures by OVC employee households on final goods and services, after income taxes levied on OVC payroll and after savings by OVC employee households on disposable income.

After OVC makes payroll expenditures, income taxes are charged, and a portion of disposable income will be saved by employee households receiving these salary payments. Both the income taxes deducted at source by OVC as the employer and the portion of OVC payroll expenditures representing employee savings are unavailable for spending by these households on final goods and services and therefore do not generate economic impact. We applied tax and saving rate assumptions (based on Statistics Canada and tax rate information) to the payroll expenditures provided by OVC, before modeling the economic impacts of these expenditures using the Statistics Canada multipliers. Put another way, we have assumed that the OVC data represented pre-tax payroll expenditures, and that the direct effects reported in our deliverable were based on consumption by OVC employee households, or on the final goods and services that they purchase after receiving salary payments.

To calculate these savings and income tax rates, we first took the sum of salary amounts from line items in the “*Table2*” workbook noted in Figure 1. To this amount, we then deducted personal tax and personal savings rates, using data from CANSIM Table 380-0072,⁸ to estimate the proportion of payroll dollar figures spent on final goods and services.

⁷ See footnote 1 for the data source.

⁸ This data is available at

<http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3800072&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid>.

Next we constructed a weighted-average multiplier for household consumption expenditures, assuming a spending pattern across different industries, based on data provided by Statistics Canada.

Since consumption by OVC employee households includes expenditures on goods and services produced by a variety of industries, we constructed a household consumption multiplier by weighting industry multipliers. To do this, we took the spending pattern within the “P5000: Wages and salaries” row of the “2010 Provincial Symmetric Input-Output Tables” for Ontario – Summary Aggregation, provided by Statistics Canada.⁹ We sourced the expenditure amounts from this row, reported by industry receiving these expenditures, to define the weights at an industry level. Then, we calculated the weighted average of the industry multipliers as the payroll multiplier to be applied to the proportion of disposable income representing household consumption expenditures.

Fiscal/Tax Impacts

Using Statistics Canada multipliers, we sourced fiscal/tax impacts solely from the 13% Harmonized Sales Tax (HST) as charged on all OVC line item expenditures except for payroll expenditures.¹⁰ Additionally, we assumed a total government spending amount equal to 13% of the line items subject to HST.¹¹ To create a single government spending multiplier, we weighted multipliers from the six government sectors shown in the Provincial Summary Aggregation multiplier table,¹² by the expenditures shown in the row totals for each of the six government sectors in the Symmetric Input-Output tables.¹³ For further detail, please see the “Salary_Tax_Multiplier_Support.xlsx” workbook.

The Fiscal/Tax Impacts reported represent economic output attributable to government expenditures on final goods and services, with the direct effect equal to the amount of the HST tax revenue received from OVC purchases of goods and services deemed subject to the tax.

Calculating Salary and Tax Impacts: From IMPLAN

Using IMPLAN, we modeled salary impacts as a Labor Income Change within the software. It was not necessary to make additional assumptions regarding items such as savings or tax rates within this software, since IMPLAN includes standard assumptions on these items. Tax impacts are typically shown within IMPLAN using the Tax Impact report from the corresponding Industry Impacts, however IMPLAN did not include the Tax Report for the Ontario Provincial data model.

Discounting Dollars Over Time

OVC reports line item expenditures by academic year. We reported data from the 2008/2009 academic year through the 2012/2013 academic year, for a total of five academic years.¹⁴ Dollars for each line item were then converted from the last calendar year of each academic year, to 2010 dollars, by using CANSIM Table 326-0021 containing yearly Consumer Price Index data for Ontario.¹⁵ After this price level adjustment, the 2010 Statistics Canada multipliers were then applied to the data, resulting in direct, indirect and induced effects being estimated in 2010 dollars. Following this estimation, the impacts were summarized for the output deliverable worksheets, and reported in two years; in dollars from the year in

⁹ The symmetric input-output tables show expenditures made by sectors and received by others. This data is available by request from Statistics Canada under catalog number 15-211-XCE, and is not available on the Statistics Canada website.

¹⁰ For industry impacts, this means that the direct effect for fiscal/tax impacts is equal to 13% of the final goods expenditure. For payroll impacts, this means that the fiscal/tax impacts only include government spending that is based on sales tax receipts levied on the proportion of disposable income that represents consumption expenditures made by households. Put another way, we have not assumed any government spending of income tax receipts from payroll expenditures.

¹¹ This assumption is conservative in the sense of providing a lower bound for government expenditures that would follow sales tax receipts. While it is alternatively possible to assume a government deficit, or that government spending would exceed government tax receipts, we have not used data to match receipts to spending.

¹² The government sectors are given by GS* sector rows in the data source; see footnote 1.

¹³ See footnote 6.

¹⁴ The OVC Capital Expenditures data included results from the 2013/2014 academic year as well, however this year was not included in the Operating Expenditures data; because of this omission, we did not include the 2013/2014 academic year expenditures in the reported results.

¹⁵ This data is available at

<http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3260021&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=>

which the OVC academic year ended, as well as in 2013 dollars; the latter, in order to sum dollars for the entire five-year period, and to provide a current time basis for reporting.¹⁶

Impact Analysis

The following is a summary of the various economic impacts generated from OVC's operations, which includes its operational expenditures (such as salaries and supplies) as well as capital expenditures it undertakes (such as building or expanding buildings):

Economic Spend:

The following outlines the direct spend per year by OVC adjusted to 2013 dollars, the indirect and induced economic impacts. The average economic impact over the five year period was just over \$125 million per year.

Table 3: Direct spend per year by OVC adjusted to 2013 dollars, the indirect and induced economic impacts

Data Year	Price Level Reporting Year	Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
2008/2009	Adjusted to 2013 dollars	Output	\$66,891,498	\$28,409,356	\$23,096,234	\$118,397,088
2009/2010	Adjusted to 2013 dollars	Output	\$95,921,758	\$41,692,772	\$32,486,817	\$170,101,346
2010/2011	Adjusted to 2013 dollars	Output	\$72,588,246	\$30,525,398	\$24,477,390	\$127,591,035
2011/2012	Adjusted to 2013 dollars	Output	\$62,222,844	\$25,492,814	\$20,993,181	\$108,708,840
2012/2013	Adjusted to 2013 dollars	Output	\$58,116,599	\$23,371,337	\$19,453,586	\$100,941,522
ALL	Total	Output	\$355,740,944	\$149,491,678	\$120,507,208	\$625,739,830
	Average		\$71,148,189	\$29,898,336	\$24,101,441.51	\$125,147,966

Labour Income

The following outlines the total of labour income generated by OVC:

Table 4: Total of labour income generated by OVC

Data Year	Price Level Reporting Year	Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
2008/2009	Adjusted to 2013 dollars	Labor Income	\$25,116,890	\$9,892,712	\$6,572,652	\$41,582,254
2009/2010	Adjusted to 2013 dollars	Labor Income	\$35,959,254	\$14,502,837	\$9,245,056	\$59,707,147
2010/2011	Adjusted to 2013 dollars	Labor Income	\$26,837,252	\$10,608,125	\$6,965,715	\$44,411,093
2011/2012	Adjusted to 2013 dollars	Labor Income	\$22,742,933	\$8,868,674	\$5,974,163	\$37,585,770
2012/2013	Adjusted to 2013 dollars	Labor Income	\$21,092,296	\$8,105,788	\$5,536,025	\$34,734,109
ALL	Total	Labor Income	\$131,748,625	\$51,978,136	\$34,293,612	\$218,020,373
	Average		\$26,349,725	\$10,395,627	\$6,858,722.34	\$43,604,075

Employment

The following shows the total employment on an annual basis created by OVC, based upon the spending in the economy:

Table 5: Total employment created by OVC

Data Year	Price Level Reporting Year	Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
2008/2009	Adjusted to 2013 dollars	Employment	498	159	120	777
2009/2010	Adjusted to 2013 dollars	Employment	653	230	169	1,053
2010/2011	Adjusted to 2013 dollars	Employment	515	170	127	813
2011/2012	Adjusted to 2013 dollars	Employment	453	144	109	706
2012/2013	Adjusted to 2013 dollars	Employment	437	132	101	670
ALL	Total	Employment	2,557	834	628	4,018
	Average		511	167	126	804

Taxes

The following shows the total taxes created by the economic impacts of OVC:

¹⁶ Reported employment results were not discounted for inflation, since price levels were observed across all sectors as opposed to within sectors. No price index was available for the year 2014, as this data is not yet available.

Table 6: Taxes created by the economic impacts of OVC

Data Year	Price Level Reporting Year	Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
2008/2009	Adjusted to 2013 dollars	Fiscal/Tax	\$8,695,895	\$3,580,627	\$3,830,423	\$16,106,945
2009/2010	Adjusted to 2013 dollars	Fiscal/Tax	\$12,469,828	\$5,134,584	\$5,492,790	\$23,097,202
2010/2011	Adjusted to 2013 dollars	Fiscal/Tax	\$9,436,472	\$3,885,568	\$4,156,637	\$17,478,677
2011/2012	Adjusted to 2013 dollars	Fiscal/Tax	\$8,088,970	\$3,330,719	\$3,563,081	\$14,982,770
2012/2013	Adjusted to 2013 dollars	Fiscal/Tax	\$7,555,158	\$3,110,916	\$3,327,944	\$13,994,018
ALL	Total	Fiscal/Tax	\$46,246,323	\$19,042,415	\$20,370,875	\$85,659,612
	Average		\$9,249,265	\$3,808,483	\$4,074,175.00	\$17,131,922

Summary of Economic Impact

In total the economic impact based strictly from OVC's operational expenditures is significant. The table below summarizes the average impacts from operations from the last five years. On average, OVC generates more than \$125 million of economic activity per year and generates more than 804 jobs.

Table 7: Annual Economic Impact of OVC Operations

Impact	Amount
Total Economic Impact	\$125,147,966
Total Employment Income	\$43,604,075
Employment - jobs	804
Total Tax Revenue	\$17,131,922

Leveraging Public Funds

The OVC is funded from a number of sources to support its operations; in 2013/2014 total OVC revenue was about \$63.5 million, the components of this funding is outlined in figure 1 on the following page. The OVC received approximately \$34.4 million in Operating Funding from the Government of Ontario through the Ministry of Training, Colleges ("MTCU") and OMAFRA, which represents the College's "base funding". The breakdown of this base level funding is outlined in figure 2 and represents slightly more than half of the total funding of the College. There is additional funding from these government agencies for various performance-based initiatives or programs. The OVC, however, generates significant funds from non-government sources related to its activities (hospital), research, as well as donations or revenue from endowments. These additional sources of funding represent more than 40% of the total budget (see figure 1). These additional revenue sources allow the OVC to leverage its core government funding into a larger economic impact. Effectively OVC is able to take \$34.4 million in operating grants and leverages that base funding to generate total funding of \$63.5 million which generates approximately \$125 million in total economic benefit.

Figure 1: OVC Breakdown of Total Funding FY 2013/14

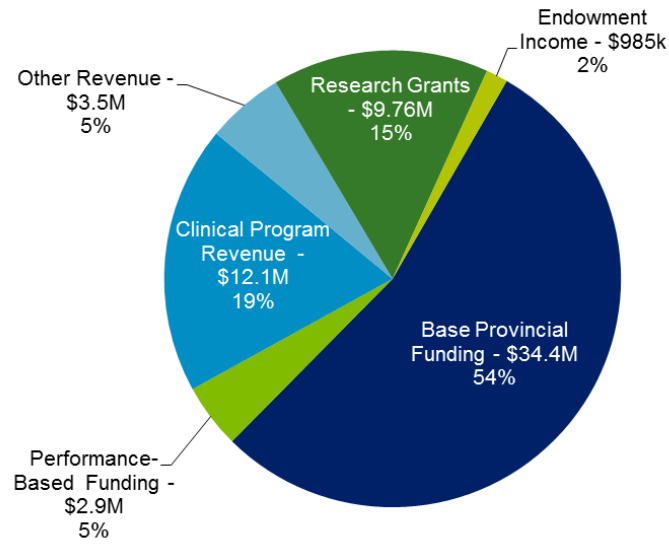
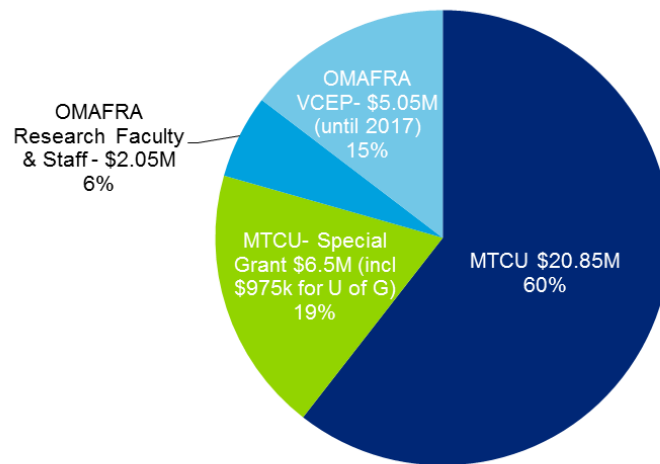


Figure 2: OVC Breakdown of Base Provincial Funding FY 2013/14



3. Additional Economic Impacts

As noted in the previous section, the economic impact of the operations of OVC is important, particularly to the economy of the greater Guelph area. However the economic impact associated with its graduates is also important for readers to understand. The “production” of graduates is one of the critical roles that OVC undertakes and the contribution of these graduates magnifies the total impact that OVC makes in the Province. The OVC is the largest producer of veterinarians in Canada and the vast majority of OVC graduates work in the Province of Ontario after graduation. These graduates assume roles in a variety of areas in the economy including food production, public sector, pharmaceutical industry and in private practice. The economic impact of veterinarians in the economy is very significant and this section of the report will outline this impact on the broader Ontario economy.

Clinical Practice of Veterinary Medicine in Ontario

More than 44%¹⁷ of these veterinarians are self-employed, meaning that they themselves create economic impact in the province based on their spending and hiring activities. It is estimated by the Ontario Veterinary Medical Association (“OVMA”) that there are approximately 1,100 veterinary practices in Ontario, with each practice generating economic activity from its spending patterns. The OVMA conducted a recent survey on veterinary practices in all provinces in Canada. The survey grouped respondents into two categories of veterinary practice, companion animal practice and mixed animal (rural) practice. A companion animal practice usually treats dogs, cats and may also treat pet birds, small mammals and caged reptiles. Mixed animal practices will treat companion animals and large animals (horses, food animals)

We utilized information from the OVMA 2012 economic report survey results to develop the average economic impact of a veterinary practice in Ontario. We developed the averages based upon survey information that listed the percentage of revenue used for various costs (such as drugs and supplies). Veterinarian income is listed as “DVM” costs and relates to owner and associate salaries, all bonuses paid to DVMs and practice net income. The averages are based on an individual or “Full Time Equivalent basis”. Thus the average costs shown in the chart below shows the economic impact for a veterinarian in private practice.

¹⁷ http://www.servicecanada.gc.ca/eng/qc/job_futures/statistics/3114.shtml#stats

Table 8: Average Annual Revenue and Expenses: Per Veterinarian in Companion and Mixed Animal Practices in Ontario

	Companion	Mixed
Total Revenue	\$ 498,820	\$ 387,136
Expenditures		
Drugs and Supplies	\$ 132,187	\$ 131,626
NON DVM Wages	\$ 104,752	\$ 58,070
Specialists	\$ 2,494	\$ -
Rent	\$ 27,934	\$ 11,614
Office	\$ 8,979	\$ 7,743
Accounting and legal	\$ 4,988	\$ 3,871
Bank charges	\$ 9,478	\$ 7,743
Depreciation	\$ 7,482	\$ 7,743
Utilities	\$ 7,482	\$ 3,871
Repairs and maintenance	\$ 6,983	\$ 3,871
Laboratory	\$ 11,972	\$ 3,871
Professional dues	\$ 2,993	\$ 3,871
Other	\$ 1,496	\$ -
Advertising	\$ 4,988	\$ 3,871
Equipment Rental	\$ 2,494	\$ 3,871
Bad Debt	\$ 499	\$ 3,871
Vehicle	\$ -	\$ 11,614
Grooming	\$ 998	\$ -
Continued Education	\$ 2,494	\$ -
Insurance	\$ 3,492	\$ 3,871
DVM costs	\$ 154,634	\$ 116,141
Total Expenditures	\$ 498,820	\$ 387,136

Source: 2012 Ontario Economic Report, Ontario Veterinary Medical Association, all numbers presented are in 2010 values.

We took these average expenditures and applied a similar economic impact analysis as outlined in the previous section to determine the average economic impacts for each veterinarian in private practice.

Table 9: Average Annual Companion Animal Practitioner Economic Impacts

Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Impact	\$451,728	\$182,313	\$138,788	\$772,829
Labor Income	\$146,558	\$62,017	\$39,496	\$248,071
Employment	2.3	1.0	0.8	4.1
Fiscal/Tax: HST/Sales Tax	\$28,895	\$11,898	\$12,728	\$53,521
Fiscal/Tax: Income Tax	\$50,800	\$20,917	\$22,376	\$94,093

Table 10: Average Annual Mixed Animal Practitioner Economic Impacts

Measurement	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Impact	\$353,044	\$141,904	\$108,803	\$603,751
Labor Income	\$114,244	\$47,725	\$30,963	\$192,932
Employment	1.7	0.8	0.6	3.1
Fiscal/Tax: HST/Sales Tax	\$19,222	\$7,915	\$8,467	\$35,604
Fiscal/Tax: Income Tax	\$39,702	\$16,348	\$17,488	\$73,538

Overall Economic Impacts of Private Practices in Ontario

Overall, the companion animal practices have a higher employment factor and have a greater direct economic impact without taking into consideration the impact on animal food animal industries discussed in next section. The above amounts are for an average practice. To determine the total economic impact of practices in Ontario, we assumed that there are approximately 1,900 veterinarians in private practice (based on OVMA data). Though the exact classification of practices was not readily available, we assumed that two-thirds of the practices were companion animal practices and one-third was mixed animal practices. Based upon these assumptions, the total economic impacts for each type of practice were:

Table 11: Total Economic Impacts for Each Type of Practice

Measurement	Companion Animal	Mixed Animal	Total
Impact	\$997,464,393	\$389,620,361	\$1,387,084,754
Labor Income	\$320,177,400	\$124,505,449	\$444,682,849
Employment	5,301	2,025	7,327
Fiscal/Tax: HST/Sales Tax	\$69,077,853	\$22,976,387	\$92,054,240
Fiscal/Tax: Income Tax	\$121,443,017	\$47,456,308	\$168,899,324

The total, overall economic impact of veterinarian practices across Ontario is estimated to be approximately \$1.3 billion per annum, generating over \$444 million of labour income in the Province.

Veterinarian Support of Critical Food Animal Industries

Veterinarians support critical food industries in the Province of Ontario. These industries include the production of dairy and egg products and meat products such as pork, chicken, turkey and beef. Without veterinarians performing critical health and preventive services, as well as regulatory and research services, a significant portion of the Ontario economy would be at risk.

To obtain a sense of the macro view of the economic activity generated by the animal agriculture industry, we reviewed the gross domestic product statistics from Statistics Canada for a few select and directly linked industries by SIC number. The economic aggregate of the activities in these economic sectors add up to more than \$20 Billion and generated more than 78,000 jobs (note 2010 statistics).

Table 12: Economic Aggregate of Select Economic Sectors

Sector Code	Sector Name	Output	Gross Domestic Product	Labour Income	Employment
BS112000	Animal production	\$5,120,200,000	\$965,300,000	\$653,954,482	40,936
BS311100	Animal food manufacturing	\$2,293,200,000	\$610,300,000	\$278,656,930	4,648
BS311500	Dairy product manufacturing	\$4,689,400,000	\$941,500,000	\$572,123,197	7,062
BS311600	Meat product manufacturing	\$8,081,300,000	\$2,081,400,000	\$1,312,259,127	25,821
		\$20,184,100,000	\$4,598,500,000	\$2,816,993,735	78,467

To assist the reader in putting some additional context around the size of the food animal production industry, we have also included a few other key statistical references.

Farm receipts related to animal production exceed \$5 billion (2011 data Strategic Policy Branch Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs).

Table 13: Farm Receipts Related to Animal Production

Top Commodities in terms of Market Receipts	(\$ million)
Dairy products	1,895
Cattle and calves	1,028
Poultry	891
Hogs	902
Eggs	301
Total	5,017

Ontario has approximately \$2.5 billion in exported product, which represents a significant portion of all agricultural exports for the Province.

Table 14: Animal Based Exports 2011 - 2013

Exports	2011	2012	2013
Live Animals	222.9	234.2	270.5
Red meats	895.5	801.4	855.8
Poultry and eggs	186.9	203.9	191.0
Dairy Products	136.3	123.5	101.6
Other animal products	660.1	813.6	1,085.0
Total Animal based exports	2,101.80	2,176.50	2,504.00
TOTAL Exports All Products	9,922.30	10,827.20	11,863.10

4. Impact of Health Management Activities & Research and Innovation at OVC

Food Animal Health Management: Safeguarding Billions in Economic Activity

The food animal production industry contributes more than \$20 billion to the provincial economy on an annual basis. Food animal veterinarians are critical providers of herd health management and work in private practices, government and other animal health industries serving the more than 218 million dairy cows, swine and poultry in the province of Ontario.

Food Animal Health Management in Industry

Food Animal Health Management is the practice of ensuring that the health, welfare and productivity of livestock are maintained and improved to safeguard the food production industry and guarantee a safe food product for consumers. Food Animal Health Management specifically focuses on the sustainability of food production practices and the welfare of the animals in question.

Food Animal Health Management at OVC

The OVC maintains one of the largest and most internationally well respected Health Management programs in the world. Prevention of disease and protection of food safety are key components of this program.

Teaching

The OVC's teaching and learning mission is to assist students in developing an appropriate level of knowledge as well as the necessary communication, quantitative and problem-solving skills to use this knowledge effectively to ensure the health of animals, and assist livestock producers and government agencies. The Veterinary Clinical Education Program ("VCEP"), funded by the Ontario Ministry of Agriculture and Food and Rural Affairs ("OMAFRA") provides critical support for the hands-on teaching of the clinical aspects of the program.

As a part of the learning mission, faculty take students to participating farms to provide services directly to farmers, which develops the students' knowledge base and skills and improves the College's value-add to the food animal industry. This experience with commercial farms also attracts more students to the production animal industry. Eighty per cent of health management teaching in the final year of veterinary school is on-farm through applied and integrated teaching.

"OVC not only does an excellent job providing its students with that base knowledge but also instills in them the principles and critical thinking skills they need to flourish in industry." – Dr. Ray Reynen, Veterinary Practitioner and graduate from OVC.

Research

Research is largely driven by industry and government priorities and needs. Faculty at OVC are highly integrated with and engaged with the poultry, swine, and dairy and sheep/goat industries. The College's specific health management research mission is focused on the management of health and productivity of

animal populations and the interrelationships with humans and the environment. For this reason, a large portion of the research the College undertakes is on commercial farms. This health management research consists mainly of randomized clinical trials and quantitative observational studies of preventative and therapeutic techniques to keep animals healthy. This research is possible due to the respect and trust the industry has for OVC and the importance of the research to the industry.

Between 2009 and 2013, industry and businesses across Ontario invested an average of \$1.6 million per year into health management research at OVC.

Health management researchers have leveraged those industry and business dollars into average research investments of more than \$230,000 per year from the Natural Sciences and Engineering Research Council and an average \$1.2 million per year from OMAFRA research funds over the same time 2009-2013 period.¹⁸

“OVC is a recognized leader in veterinary medicine and its faculty are known as leaders in their respective fields. I am amazed by the number of times I hear work by OVC faculty being quoted and discussed by people from all across the globe whenever I attend conferences.” - Dr. Ewen Ferguson, Veterinary Practitioner and graduate from OVC.

Knowledge Transfer

The College's health management program integrates with industry in two different initiatives. The first is the on-farm education provided to their students as part of their practical approach to teaching. Placing students on farms to work with farmers on a daily basis ensures that knowledge developed is highly applicable to “real life” issues and has a high impact on producers. The second involves the dissemination of the outcomes of their research to the industry. The high degree of interaction that OVC has with producers allows for findings at OVC to be effectively disseminated to industry and, as a result, industry is highly supportive of the work that goes on at OVC. Health management faculty and researchers are sought after for local, national and international speaking engagements at producer, industry and scientific conferences and meetings.

Dairy Famers of Ontario: The Dairy Farmers of Ontario (“DFO”) recently provided a gift to the University of Guelph of \$3 million with the objective of keeping Ontario and Canada at the forefront of dairy production and health. \$1 million of the funding was to establish a research chair in dairy cattle health at the Ontario Veterinary College. This contribution coincides with the construction of a \$25 million, state-of-the-art dairy research facility at the University of Guelph-run Elora Research Station for which DFO is also committing up to \$5 million on behalf of industry stakeholders.

Bovine Education Trust: Established by the Ontario Veterinary College in partnership with the Ontario Association of Bovine Practitioners, the Bovine Education Trust gives student veterinarians greater opportunity to learn on-the-job skills, an objective that is important for a number of reasons. The public wants safe and abundant food, producers want assurance of care and insightful advice and practising veterinarians want a talented new generation to carry on their work. All of these require that veterinarians in training are given the opportunity to get involved with industry early on and the Bovine Education Trust specifically provides students with opportunities for summer placement, extracurricular learning opportunities and external electives.

OVC's Impact on Food Animal Health Management

As mentioned above, Ontario's food production industry is a major contributor to its economic activity, contributing approximately \$20 billion to the provincial economy on an annual basis. To support this industry, 1,600¹⁹ veterinarians who are employed in mixed and large animal practices and 450 in related government and industry, were licensed in Ontario in 2012. The vast majority of these veterinarians

¹⁸ Estimated numbers extracted from the Office of Research data for project sponsors and dollars per department. <http://www.uoguelph.ca/research/about-us/fact-figures>

¹⁹ License to practice veterinary medicine - OVMA

graduated from OVC. In addition, OVC research disseminated to industry contributes essential knowledge to address animal health issues and respond to threats to health and safe food as they occur,

Farmers also benefit from the hands-on training and expertise offered by OVC. More than 800 farm visits for both health management and teaching purposes, involving more than 1.3 million animals are made to dairy, swine, poultry, beef, sheep, goats and elk farms each year. Of these, OVC provides ongoing health management services to more than 70 farms with more than 550,000 animals, including more than 2,200 dairy cows, 1,100 beef, 3,700 sheep, 109,000 swine and 440,000 poultry. Farm visits require hands-on work with specific individual animals (e.g., complete physical exam, blood sample, pregnancy diagnosis) and observation of all the animals. They also include review of production records, antibiotic use and vaccination protocols on the farms.

Examples of OVC Impact

The Ontario Veterinary College is continually working to ensure the health and productivity of Ontario's livestock; the following are just a few examples of this work.

OVC Dairy Health Management Certificate Program

The Dairy Health Management Certificate Program, originally created at OVC by Dr. Ken Leslie, was established to provide vital continuing education for dairy practitioners. It has enhanced dairy health management across Ontario and provided a model for similar programs around the world. This unique two-year continuing education program, made up of a series of 12 on-campus modules, facilitates learning and networking for active dairy veterinary practitioners, as well as providing them an opportunity to network with other participants, faculty and guest lecturers. The spin-off effects of this certificate program includes improved management on the farms these veterinarians service, better integration with the agricultural industry, and improved teaching and research opportunities.

“Those that were directly involved in the [dairy] certificate program went out and taught others what they had learned and then those people went to their producers to share the knowledge and a ripple effect was created that ended up impacting a significant percentage of the dairy industry.”
– Dr. Ray Reynen, Veterinary Practitioner, participant in OVC Dairy Health Management Certificate Program and graduate from OVC.

OVC & Graduates: Work in Dairy Industry

The OVC, both directly and through its graduates, is heavily involved in the dairy industry in Ontario and across Canada through involvement in the national Canadian Quality Milk program and its ongoing work to develop an industry-wide animal care assessment model. All of these programs speak directly to how OVC and its graduates are working to meet consumer demands for safe, high-quality food.

Another example arises from an Ontario regulation, which stipulates that dairy farmers and their herd veterinarian must sign an annual declaration to attest that animal health is satisfactory, veterinary drugs are used appropriately and that a Veterinarian-Client-Patient Relationship exists. This regulatory change was required to ensure dairy products and food products containing dairy ingredients could continue to be exported from Ontario herds to the European Union.

Veterinarian input is also required for the Recommended Cattle Health Risk Assessment and Management Program (RAMP) looking at any potential health risks to calves, heifers and cows in regard to the environment or exposure to disease and to outline recommendations for the farmer to mitigate those risks.

Shipping Fever Vaccine

Dr. Pat Shewen and Dr. Bruce Wilkie, professors at OVC, developed the Presponse™ vaccine for bovine pneumonic pasteurellosis, or “shipping fever”, a major cause of sickness and death and economic losses in the beef cattle industry. Presponse™ was patented and came on the market in 1987, and since then all *pasteurella* (now called *mannheimia*) vaccines are modelled on the one developed by Shewen and Wilkie. This technology has proven to be one of the most successful innovations from the OVC, and more broadly the University of Guelph's longstanding relationship with OMAFRA.

High Immune Response Technology

High Immune Response (HIR) Technology was developed by University of Guelph researchers, led by Dr. Bonnie Mallard, to measure immune response in dairy cattle and their ability to combat infectious disease.

This technology was licensed for use by Canada's largest dairy genetic company, the Semex Alliance, to identify elite sires with enhanced immune response and received one of 10 innovation awards at the World Dairy Expo in Wisconsin in October, 2013.

HIR identifies and ranks animals as high, average or low immune responders. Research has shown that high immune responders have a lower occurrence of diseases, such as mastitis, which costs the dairy industry \$345 per case, with up to 1 in 4 cows affected in a dairy herd²⁰. Identifying these animals provides a number of benefits for both the animals and dairy farmers. High responders also have a better response to commercial vaccines and produce more protective colostrum, which produces healthier calves. This translates to healthier cows and lower disease treatment costs.

Johne's Disease

Johne's disease is a chronic debilitating disease that affects the intestines of cattle, sheep and goats.²¹ It can have a significant impact on the dairy industry as it causes lower milk production and premature culling of herds when infected cows are found.²² As part of an initiative jointly supported by \$2.1 million of funding from the Dairy Farmers of Ontario (DFO) and \$300,000 from OMAFRA, and a number of other associations, the OVC under the leadership of Dr. David Kelton, who is the DFO Chair in Dairy Cattle Health, developed and administered the Johne's Education and Management Assistance Program for Ontario Dairy Producers. The program focused on educating farmers and veterinarians about Johne's disease; conducting annual on-farm risk assessments; implementing a milk testing program that reimburses farmers up to \$8 per cow tested; and working with producers to ensure that cattle actively shedding Johne's bacteria are removed from the herd and do not enter the food chain. The intent of the program was to increase biosecurity and enhance the ability to trace the disease. Information regarding the program has successfully reached every dairy farm in Ontario of which two-thirds have acted on the information and advice provided by the program.

Ketosis

High-producing dairy cows have been described as metabolic athletes. Their energy expenditure is equivalent to a person running a marathon every day. It is common for cows to slip into ketosis, a condition of a build-up of incompletely burned body fat that can suppress appetite, increase susceptibility to other diseases, and reduce performance. Researchers at OVC have been international leaders in advancing understanding of ketosis and its diagnosis, effects and treatment.

Much of the original work on ketosis was spearheaded by a clinical trial that evaluated a novel application of an anti-bloat agent for prevention of ketosis. This work, led by Dr. Todd Duffield at OVC, led to regulatory approval for monensin as an aid in the prevention of ketosis in Canada. Approximately 300,000 dairy cows per year receive the benefit of this research in Canada alone. In addition, researchers from this project have been, and continue to be, invited to speak on ketosis management internationally to veterinary, advisor and producer audiences. The product has now received regulatory registrations in many dairy producing countries including Mexico, Argentina and Brazil, Australia, New Zealand, and most recently in both western and eastern Europe, including the Netherlands, Germany, France, United Kingdom, Italy, Spain, Poland, and the Czech Republic.

Swine researchers react quickly to industry needs

Scientist veterinarians at the OVC are prepared to respond quickly to industry and government requests as evidenced by the recent outbreak of Porcine Epidemic Diarrhea (PED), a viral disease causing vomiting, diarrhea and high death loss in pigs. PED caused widespread concern throughout the swine industry and OVC researchers rapidly mobilized an investigation comparing farms where PED occurred to those where it did not, as well as farms that received suspect feed with those that did not, to determine causes of the outbreak.

Collaboration with industry is vital to gather data and monitor diseases such as Porcine Reproduction and Respiratory Disease (PRRS) and PED. The OVC and the Ontario swine industry have developed a complex database, compiled from multiple sources, including veterinary practitioners and swine producers and OVC's previous research. The database contains geographical locations, biosecurity information, and reports from important networks, providing the information that OVC researchers need to

²⁰ Canadian Bovine Mastitis and Milk Quality Research Network (<http://www.medvet.umontreal.ca/rcmb/en/page.php?p=166&tm=i>)

²¹ [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex742](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex742)

²² Johne's article December 2013 Milk Producer Magazine

analyze diseases such as PRRS and PED and produce tools and applications for industry. Also vital to the swine industry is ongoing research at OVC into areas such as antimicrobial resistance and animal welfare.

Practical Biosecurity: From Farmers for Farmers

Biosecurity involves the development and implementation of preventive measures on farms that help to maintain animal health and prevent spread of disease. Insufficient biosecurity measures can increase the mortality rate from disease, which can have a negative impact on the provincial economy and, for some infectious diseases, may spread to the human population. The Poultry Industry Council (PIC), a non-profit organization dedicated to “encouraging and financing research and education for the benefit of the poultry industry in Ontario”²³, approached the OVC to develop an educational tool that could be used to increase biosecurity compliance by poultry producers across the Province. Using funding from the OMAFRA Knowledge Translation and Transfer (KTT) program, Dr. Michele Guerin and students, in collaboration with the Ontario Agricultural College (OAC) and PIC, interviewed poultry farmers across the Province to develop best practices for biosecurity. The end product of this initiative was the development of the DVD “Practical Biosecurity: From Farmers for Famers” which was distributed to all Ontario poultry producers.

Conclusion

Food Animal Health Management is a critical component in maintaining the economic viability and sustainability of Ontario’s food production industry while ensuring the welfare of the animals involved and a safe food product for consumers. The OVC, as one of the largest and most well respected programs of its kind in the world, is an essential link in the development and maintenance of health management standards and protocols in an ever-evolving landscape. The positive influence it has on the food production industry in Ontario is the result of three levels of impact: the supply of highly trained veterinarians who can work with farmers to provide health management programs for herds and flocks in Ontario, the output of highly relevant research to continually assist the industry, and the effective dissemination of that research because of OVC’s close ties with industry. Furthermore, the continued efforts of OVC and its practicing graduates in Ontario act to reassure the general public that their food will continue to be safe.

²³ <http://www.poultryindustrycouncil.ca/boardroom-booking-2/>

Public Health and Zoonoses - Educating and Protecting the People of Ontario from Animal Transmitted Diseases

Greater than 60% of new or emerging infectious diseases that threaten human health can be transmitted from animals to people.

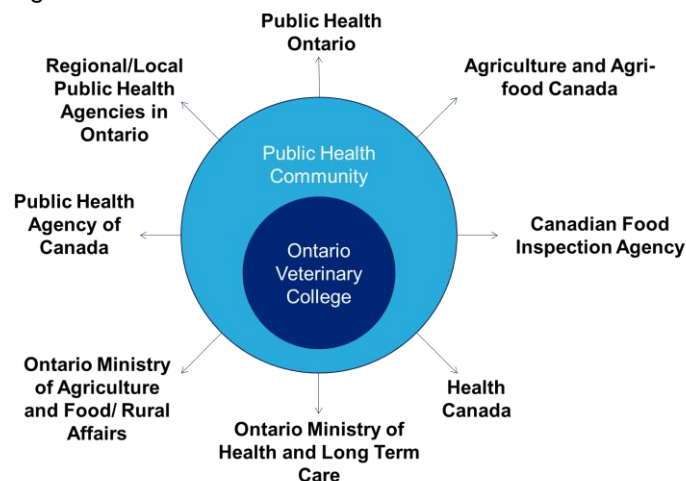
The continuum that exists between animal and human health is of major importance to the health and safety of Ontario's inhabitants, both human and animal. Thus, it is essential that health issues are tackled from both the human perspective and animal perspective. This unique connection between humans and animals is the result of a number of intersections that exist between them. People interact with animals as a food source, as animal companions and as "environmental neighbours". This, combined with other factors such as global trade, aging demographics, drug resistance and pathogen mutations, creates a situation where zoonoses are a critical topic.

A zoonosis is "any disease or infection that is naturally transmittable from vertebrate animals to humans"²⁴ Due to the impact they can have on the health of human populations, zoonoses are an important consideration for public health professionals across the globe. In recent years incidences of "pandemic flu", "West Nile", and "Lyme disease" have all been the subject of media and public focus. In addition to significant human health considerations, these diseases can also have significant economic implications, including trade bans on products, negative impacts on travel and tourism and increased spending on health care. The global outbreak of Severe Acute Respiratory Syndrome ("SARS"), a zoonotic disease, claimed 800 lives and caused an estimated \$50 billion in economic losses globally.²⁵

There are a number of converging factors that have led to zoonoses being a critical public health subject, including increasing demand for animal protein, human behavioural changes, shortfalls in the public health infrastructure and various factors associated with disease-causing agents²⁶:

OVC: A Critical Component in Public Health and Zoonoses Research and Practice

As a leading authority on zoonoses, the OVC plays an indispensable role in the protection of public health in Ontario, as well the maintenance of an abundant, affordable, safe and sustainable food source for Ontarians. OVC is a vital contributor to public health and collaborates with a number of local, provincial and federal government agencies and departments across the public health community. Furthermore, OVC's importance to the public health community is exemplified by the fact that many of its graduates work at these and other organizations.



OVC's commitment to public health is demonstrated with the establishment of The Centre for Public Health and Zoonoses (CPHAZ) in 2006. The mandate of CPHAZ is to focus on and lead research,

²⁴ World Health Organization - <http://www.who.int/topics/zoonoses/en/>

²⁵ The Economic and Social Impact of Emerging Infectious Disease, Marsh, 2008

²⁶ The Economic and Social Impact of Emerging Infectious Disease, Marsh, 2008

education, and knowledge dissemination in public health at the human-animal-environment interface. Collaborations of OVC members with external collaborators and partners are a key function of CPHAZ.

The prevention and control of zoonotic pathogens requires multiple activities, from understanding the pathogens and their transmission, to designing diagnostic tests, to developing potential control or prevention strategies, to testing those strategies in the field. There is also an educational component as OVC scientists actively disseminate the information to the end-users such as livestock producers, pet owners, physicians and veterinarians. In turn, by working closely with the industry and other knowledge end-users, OVC receives feedback about important issues and concerns, which serves to enhance the relevance of its work.

OVC does significant research into food safety and zoonotic pathogens and the diseases they cause, identifying risk factors and how to manage them, with particular emphasis on antimicrobial resistance. OVC scientists provide scientific input to related policy development in the public health field. These functions, along with the management techniques they develop and implement to prevent outbreaks make the Ontario Veterinary College an essential resource to the public health field and for the people of Ontario. In addition, the OVC has a unique Masters of Public Health degree program that emphasizes animal-related public health. This year more than 300 individuals applied for the 20 seats in the program – a testament to the quality and reputation of the program.

A Guelph Infectious Disease Conference was held in September 2013, with attendance of local hospital infection prevention and control personnel, hospital administrators and public health personnel. The meeting covered treatment of recurrent *Clostridium difficile* infection (Dr. Scott Weese), zoonotic influenza viruses (Dr. Zvonimir Poljak), multidrug resistant gram-negative bacteria (Dr. Patrick Boerlin) and hand hygiene monitoring methods (Dr. Maureen Anderson). The one-day conference increased communication between the OVC and local human medical and public health personnel and informed them about important OVC research.

Monitoring & Collaboration

OVC scientists are involved in a number of initiatives that help track zoonotic pathogens and coordinate efforts for prevention and control. This involves long-term studies in a variety of species to monitor trends in the frequency of zoonotic pathogens and shorter-term studies to establish frequency and presence of the pathogen.

OVC faculty are involved in sampling food animals for enteric (gut) pathogens as a collaborative effort with the Public Health Agency of Canada (PHAC). The scientists conduct surveillance studies to detect the same pathogens in the same geographic area in food from grocery stores and in humans. This surveillance provides information to the food animal producers and also to public health officials about the risks of certain pathogens.

The OVC fulfills an important role investigating more than 50 different pathogens across multiple species and the zoonotic diseases caused by those pathogens. OVC scientists are also involved in the prediction of the significance and the monitoring of emerging zoonoses.

The Animal Health Laboratory

The Animal Health Laboratory (AHL) is located at the University of Guelph and its proximity to OVC, both geographically and in terms of mission alignment, allows regular collaboration. The output of this collaboration and the work of the AHL identifies approximately 1,000 cases of zoonotic pathogens from domestic and non-domestic animals each year including bacteria, viruses and parasites.

FoodNet Canada and the Canadian Integrated Program for Antimicrobial Resistance (CIPARS) – Public Health Agency of Canada

OVC collaborates with the Public Health Agency of Canada (PHAC) on two surveillance programs, FoodNet Canada, which supports activities to reduce the burden of enteric or gastrointestinal illnesses, and the Canadian Integrated Program for Antimicrobial Resistance (CIPARS), which monitors trends in antimicrobial use and antimicrobial resistance in selected bacterial organisms from human, animal and food sources across Canada.

The relationship identifies “data gaps” and uses basic and applied research by scientists at OVC. Students often use data from these projects for their thesis research, which leverages PHAC resources to explore and publish important information that they might not otherwise have the time to do.

The Canadian Cooperative Wildlife Health Centre

Health and disease of wildlife, domestic animals and humans are linked through the sharing of zoonotic pathogens. Public health organizations and veterinary diagnostic laboratories have long provided information on the occurrence of disease in humans and domestic animals, but historically, surveillance for disease in wildlife has been limited. In recent decades, the emergence of new diseases and the geographic spread of others have given new emphasis to the importance of wildlife disease to human and domestic animal health.

The Canadian Cooperative Wildlife Health Centre (CCWHC), established in 1992, is a national partnership of universities, federal, provincial and territorial government agencies and the private sector to provide surveillance of wildlife health and disease, and research and education programs in support of wildlife health. The CCWHC operates out of Canada’s five colleges of veterinary medicine and is a Collaborating Centre of the World Organization for Animal Health (OIE). The Ontario/Nunavut regional centre of the CCWHC is based at OVC.

In Ontario, the CCWHC was in the forefront of surveillance for West Nile virus, which causes disease in people, horses and some bird species, first arrived in North America in 1999. The OVC CCWHC centre has continued to monitor the occurrence of the virus in wild birds, providing an early warning system for its presence in the environment. The centre also participates in a national surveillance program for avian influenza virus in wild birds and Lyme disease in Ontario.

OVC’s pioneering research on Food Safety

The OVC has a long history of involvement with public health and food safety -- from Dr. Andrew MacNabb, who was instrumental in the introduction of compulsory milk pasteurization in 1937 thus preventing illnesses caused by milk-borne agents such as tuberculosis -- to eradicating tuberculosis and brucella in our dairy and beef cattle, to present day concerns such as E. Coli O157, to what many people believe will be a huge public health challenge in the future – antimicrobial resistance.

One example of the important contribution the OVC makes to food safety and public health is its involvement in The Canadian Global Food Animal Residue Avoidance Databank (CgFARAD). OVC faculty member, Dr. Ron Johnson is a co-director of CgFARAD, a collaborative effort between OVC and the Western College of Veterinary Medicine at the University of Saskatchewan. CgFARAD is a non-profit food safety service whose goal is to mitigate the risks of drug residues in food animal products.

CgFARAD has an enormous impact on the Canadian livestock sector, which contributes more than \$43 billion to the Canadian GDP. Responding to more than 1,200 drug-related queries per year since 2002, CgFARAD provides expert opinion related to extra label drug use in all food producing species. Knowledge translation (drug depletion studies, pharmacokinetic modeling studies) and information transfer in the form of responses to queries, food safety position statements and publications, and speaking engagements to all stakeholders (regulatory agencies, pharmaceuticals industry, commodity groups and feed mill and processing plants) is a critical component of CgFARAD contributions to the Canadian and global food value chain that ensures public safety and international trading partner confidence with Canada.

Communication to veterinarians and physicians

Communicating educational information to a broad audience can be a challenge. Dr. Scott Weese has developed a blog (<http://www.wormsandgermsblog.com>) that educates people about zoonotic diseases. The blog was developed as a joint project between University of Guelph OVC’s Centre for Public Health and Zoonoses and the City of Hamilton’s Public Health Department. They identified a need for a resource that people could access that would provide them with general information they needed with regards to the health of their pets and their own health when dealing with their pets. The truly unique characteristic of this blog is that it provides educational materials geared specifically to veterinarians, physicians and the public and, therefore, helps to bridge the gap not only between the medical and veterinary spectrums of public health, but also between the work that is conducted from the human and animal perspectives.

OVC in Public Health: Illustrative Examples of Research and Practice

Walkerton

Known as Canada's worst ever *E. coli* O157 H7 outbreak, the Walkerton tragedy in the summer of 2000 resulted in 2,300 people becoming ill and seven dying as a result of a breakdown in water treatment in the area.²⁷ Public health crises like this one reiterate the importance of established communication protocols in the event of an outbreak.

Dr. Carlton Gyles, a microbiology professor at OVC who focused on *E. coli*, was called upon by media and health agencies to consult on the crisis. As he recalled several years later, investigators concluded that a multitude of compounding factors that combined to create the tragic result including "poorly sited wells...improper maintenance that allowed contamination by runoff, lax monitoring and communication of results and incompetent operators"²⁸. He emphasized that an experience like Walkerton "highlights the contribution that veterinary medicine can make to public health, from bacterial pathogens to SARS, West Nile virus and mad cow disease."²⁹

The faculty at OVC are essential contributors in food and water safety across Ontario and through them the OVC is continually working to prevent tragedies like Walkerton. And when outbreaks do occur, OVC faculty are often involved in solving the problem.

Clostridium Difficile

Clostridium difficile (*C. difficile*) accounts for approximately 25,000 deaths each year in Canada. The majority of infections are acquired within hospitals; however, infections acquired outside of hospitals in the community are increasing.

Dr. Scott Weese, Canada Research Chair in Zoonotic Diseases, has conducted studies that have identified *C. difficile* in community hospitals and long-term care facilities, in food and water, and in companion and wild animals. He is evaluating treatments for recurrent *C. difficile*, particularly examining the role of intestinal bacteria on disease recurrence and treatment.

Antimicrobial Resistance

Antimicrobial resistance is a growing concern in public health and the potential impact on Ontarians is significant. It can increase the frequency, severity and duration of bacterial infection, as well as the ability to successfully treat infection. The current overall medical costs of antibiotic resistance to the Canadian health care system, predominantly the institutions, may be as much as \$200 million per year.³⁰

OVC research in this area has contributed to policy recommendation for antimicrobial use by numerous organizations, including the Canadian Committee on Antibiotic Resistance, the Alliance for the Prudent Use of Antibiotics, the Public Health Agency of Canada, Health Canada, the United States Food and Drug Administration, the Centers for Disease Control and the World Health Organization (WHO).

As an example, Dr. Scott McEwen chaired the Health Canada Advisory Committee on Animal Uses of Antimicrobials and their Impact on Resistance and Human Health. The committee provided information to reduce the potential resistance and human health and safety impacts associated with using antibiotics in animals. The final report provided 38 recommendations to Health Canada and its partners in provincial governments, veterinary professional organizations or industry to better protect the health and interests of Canadians.

Conclusion

Examples such as these serve to underline the importance of OVC in public health and zoonoses in Ontario and Canada. Outbreaks such as occurred with *E. coli* in Walkerton, can have a devastating impact on both the economy of the Province and the health of people and animals. The OVC plays a vital role in understanding and mitigating the risk of such outbreaks of infectious diseases.

²⁷ <http://www.cbc.ca/news/canada/inside-walkerton-canada-s-worst-ever-e-coli-contamination-1.887200>

²⁸ <http://www.uoguelph.ca/atguelph/05-04-20/profile.shtml>

²⁹ <http://www.uoguelph.ca/atguelph/05-04-20/profile.shtml>

³⁰ Canadian Medical Association Journal, <http://www.cmaj.ca/content/167/8/885.full.pdf+html>

The Ontario Veterinary College plays a key role in helping local, provincial and federal public health organizations protect human health. The OVC investigates pathogens and the diseases they cause, discovering ways to prevent and control these diseases. By close collaboration with the public health sector and government agencies, OVC plays a critical role in keeping the people of Ontario healthy.

Translational Medicine: Studying Naturally-Occurring Diseases in Animals to Improve the Health of People and Animals

Translational Medicine

The Ontario Veterinary College (OVC) is a leader in veterinary health care, learning and research for the health of all species, including our own. The OVC provides important and unique opportunities to advance biomedical discovery and translational medicine within Ontario and beyond.

By examining naturally-occurring diseases and their progression within animals, researchers at OVC and its partnering organizations can develop models that can be quite useful in improving diagnostic procedures and therapies for similar diseases in people.

The College is strategically positioned in Guelph, which is within an Ontario research hub. It has a catchment area of several million people and their animals, providing an excellent opportunity to advance discovery through ongoing clinical trials. Working collaboratively with researchers and veterinarians from across the province and from around the world, the OVC aims to deliver results from laboratory bench to bedside (or cage or stall side). The development of new treatments is advanced through the use of a multi-disciplinary and highly collaborative approach. Promising translational research currently underway at OVC includes collaborative work in epilepsy, obesity, arthritis, oncology and several other areas.

Translational Medicine - Current Research

University of Guelph Institute for Comparative Cancer Investigation

The University of Guelph Institute for Comparative Cancer Investigation (ICCI) centered at OVC is only Canadian member of the U.S. National Cancer Institute's Comparative Oncology Trials Consortium. The consortium is a network of 20 universities conducting clinical trials in dogs with cancer with the objective of rapidly translating results of that research to human medicine. Dogs and cats, for example, possess many anatomic and physiologic similarities to humans as well as sharing similar environments. OVC's cancer scientists and veterinary specialists have expertise in surgical, radiation and medical oncology. Their work includes a focus on cancers that are common in both animals and humans such as lymphoma, osteosarcoma, skin cancer, mammary tumours, and oral tumours.

A core component of the ICCI is the Mona Campbell Centre for Animal Cancer, which provides advanced tools for cancer diagnosis and treatment for animals throughout Ontario. It was established with more than \$13 million in funds raised through private donations and is Canada's first comprehensive animal cancer treatment and research centre.

Another component of the ICCI is the Tumour Sample Bank, which currently contains almost 3,000 frozen tissue and fluid samples from more than 270 pets with the capacity to store up to 10,000 samples on site. The tumour bank emphasizes and maintains detailed records and data on the outcomes of animal patient diagnostics, treatments and response and survival times. This critical information provides the researchers that use the cancer samples more information than is often available from human tissue banks. The ICCI Tumour Sample Bank is the only one in Canada dedicated to animal tumours.

Researchers at other institutions working on solutions for human cancer may request tumour samples for their studies because of similarities between some human and animal cancers in the progression of the disease and the response to treatment.

Breast Cancer

Researchers, including Dr. Paul Woods, Co-Director of the ICCI, are investigating novel viruses designed to kill breast cancer and boost the immune system in cats with the disease without hurting healthy tissue. Breast cancer develops spontaneously in cats and in many ways is more similar to breast cancer in people than that which is induced in laboratory animals, such as mice. Hence, findings from the study of breast cancer in cats may have greater potential to answer some types of questions about human cancer. The work involves close collaboration with the McMaster Immunology Research Centre and is the first animal patient clinical trial funded by the Canadian Breast Cancer Foundation.

“OVC is unique in Canada due to its catchment area and the infrastructure it has available, this provides us with a tremendous opportunity to propel our research forward. Companion animals, cats in this case, give us the opportunity to implement a more robust strategy and it is our hope that by running these trials we will be able to both develop a viable treatment for domestic cats and strengthen our treatment strategy for humans...” – Dr. Brian Lichty, McMaster University’s Immunology Research Centre

This clinical trial represents one of the numerous unique opportunities at the OVC by virtue of being at the confluence of pets with a naturally-occurring disease similar to a human disease, dedicated and highly-trained veterinary specialists and researchers, cutting edge technology, and highly- motivated owners of seeking the best possible care for their pets – and at the same time helping solve the cancer challenge in people.

Osteosarcoma

Osteosarcoma is a highly metastatic aggressive bone cancer in dogs with many similarities in clinical behaviour and molecular pathology to osteosarcoma in people. For example, osteosarcoma is the cancer that afflicted Terry Fox. A multidisciplinary team of OVC faculty, composed of medical oncologists Drs. Tony Mutsaers and Paul Woods, surgical oncologist Dr. Michelle Oblak, comparative pathologist Dr. Geoff Wood, and scientists Drs. Byram Bridle, Alicia Vilorio-Petit and Brenda Coomber, is pursuing multiple avenues in the study of this primary bone cancer in both dogs and humans.

Clinical projects include trials of low dose “metronomic” chemotherapy, palliative treatment with radiation and bisphosphonate drugs, and optimization of imaging techniques to visualize cancer spread (metastasis). In the laboratory, biomedical research studies are focused on mechanisms of metastasis, identifying novel targets to sensitize bone cancer cells to chemotherapy and radiation treatment, evaluating sensitivity to oncolytic viruses, and genetic tumour profiling to define unique subclasses and treatment targets.

Many of these projects have external collaborations within Canada and across the globe such as the University of Toronto’s University Health Network, the Ottawa Hospital Research Institute, McMaster University, and St. Vincent’s Institute of Medical Research in Melbourne, Australia. Furthermore, these projects often receive direct funding from government and industry, such as Dr. Geoff Wood’s work on osteosarcoma genomics, which is funded through the Ontario Ministry of Research and Innovation’s Global Leadership Round in Genomics and Life Sciences fund.

Canine Lymphoma

Canine lymphoma is one of the most prevalent types of cancer in dogs and is generally treated with chemotherapy similar to treatments used in humans. While the chemotherapy induces clinical remission in approximately 80% of treated dogs, most dogs will relapse, resulting in disease progression and requiring further therapy³¹. Currently, there is no technique to help veterinarians predict what level of remission, if any, that an individual dog will experience with treatment. OVC, in partnership with an Ontario-based company, Rna Diagnostics, has been evaluating biomarkers that can be used as a predictive tool to identify dogs that will not have a successful response to the chemotherapy. If the veterinarian had this information, the treatment protocol could be altered earlier, which may increase the likelihood of a successful treatment by other methods. Furthermore, if the study proves successful, there is potential that new knowledge could be provided to physicians treating human cancer for application to their treatment protocols.

“Rna Diagnostics is developing a test to be used as a predictive tool to identify the response to chemotherapy; however, the human pathway has many regulatory hurdles to overcome. Veterinary science offers an alternate route to accomplish our goals and OVC has the resources and knowledge necessary to help us succeed. Our efforts to date have been successful in part due to OVC’s expertise and interest in veterinary oncology.” – Ken Pritzker, CEO Rna Diagnostics

³¹ Institute for Comparative Cancer Investigation Document

Epilepsy

The OVC's Comparative Epilepsy Program aims to study the naturally-occurring epilepsy in dogs as a model for human epilepsy in order to understand how the disease happens and how to treat it.

Humans and dogs have similar causes of epilepsy. Almost 5% of dogs are epileptic, compared to perhaps 1% of humans; in some dog breeds or families, more than 30% of the dogs are affected. Dogs and people also have similar types of seizures, similar responsiveness to anti-epileptic drugs, and similar problems with treatment, such as pharmacoresistance where the drugs have no effect.

Led by Dr. Fiona James and funded by a grant from the Canada Foundation for Innovation, this research is a collaborative effort partnering with pediatric epileptologists at the Toronto Hospital for Sick Children, the University of Helsinki, and the University of Munich.

Obesity

Obesity, a common nutritional disorder in humans and companion animals, has become a global epidemic problem over the past three decades. In 2011, 60% of Canadian men and 44% of women were found to be overweight or obese. Not only the human population but also companion animals suffer from obesity, with 50% of dogs and cats in recent studies classified as overweight or obese.

Similarities between obesity in companion animals and humans not only occur with regard to the causes, but also with regard to associated health problems. Numerous diseases, such as insulin resistance, diabetes mellitus, hyperlipidemia, hypertension, cardiovascular disease and stroke, osteoarthritis, skin problems, lower urinary tract disease, oral disease, certain cancer types and reproductive disorders, may occur with obesity. Thus obesity is a major health risk, which may decrease the quality of life and reduce life span, and is a major health risk for both the human population and our pets.

The Natural Sciences and Engineering Research Council of Canada, the Canada Foundation for Innovation and the Ontario Ministry of Research and Innovation have provided funding to OVC's Dr. Adronie Verbrugghe to determine the link between the types of microorganisms in the gut and obesity, how cats store fat, and how obesity is related to the onset of metabolic and inflammatory disturbances.

This research, which has great potential to answer questions about human obesity, will result in development and implementation of more successful weight loss programs, strategies for maintaining an ideal body weight, and preventing obesity and obesity-related health consequences.

Conclusion

As a hub for disease prevention, complex health care and research in animal diseases, the OVC plays an important role in advancing Ontario's contributions to translational medicine. By investigating diseases in animals, researchers at the OVC, working closely with partnering organizations, can expedite finding for solutions for human diseases.

Because of the College's strategic geographical positioning, it has a catchment area of several million people and their animals providing an excellent opportunity to advance discovery through studies and clinical trials.

Cancer, epilepsy and obesity research are just some of the examples of the far-reaching collaborative initiatives that the OVC is carrying out, and the support that they have from government and industry is apparent from the work they are conducting to improve the health of animals and people.

5. Short and Long Term Veterinary Medicine Needs

This section looks at the supply and demand relationship for veterinarians in Ontario and across Canada and examines how OVC is associated with this relationship. There are five veterinary medical programs in Canada, each of which has a Doctor of Veterinary Medicine (“DVM”) program that provides Canada with the veterinarians that it needs.

- Ontario Veterinary College, University of Guelph;
- Atlantic Veterinary College, University of Prince Edward Island;
- Western College of Veterinary Medicine, University of Saskatchewan;
- University of Calgary – Faculty of Veterinary Medicine; and
- Faculté de Médecine Vétérinaire, University of Montreal.

Table 15 shows the approximate number of students enrolled in each of these programs and the percentage of DVM students in Canada that each college enrolls:

Table 15: Number of DVM students by program

Program	# of Students in DVM Program	% of Total DVM Students
Ontario Veterinary College	460 ³²	30%
Atlantic Veterinary College	240 ³³	16%
Western College of Veterinary Medicine	310 ³⁴	20%
University of Calgary – Faculty of Veterinary Medicine.	120 ³⁵	8%
Faculté de Médecine Vétérinaire	400 ³⁶	26%
Total	1530	100%

As outlined in the above table OVC is the largest veterinary college in Canada and trains almost one third of all veterinarians in Canada.

Not only is OVC the largest college in Canada, it has been noted as providing a very diverse learning experience because of the agricultural diversity of the Ontario economy. The college works with diverse food animal industries (dairy, poultry, swine and to a lesser extent beef), as well as an extensive equine industry, pharmaceutical industry, zoo-related industries and other animal health industries. This diversity provides for excellent training from a Provincial and National perspective.

Veterinary Employment Statistics

Geographical Distribution

An analysis to determine where OVC graduates from 2009 – 2012 have chosen to work shows an interesting trend that is observed across the veterinary profession in that veterinary graduates predominantly choose to live in the region where they were educated. Table 4 provides the results of a sample survey conducted on the graduates from OVC and looks at where they were working one year after graduation. On average, three quarters of graduates from OVC are working in Ontario with the remainder split between other provinces in Canada and the US/internationally.

³² <https://ovc.uoguelph.ca/>

³³ <http://avc.upei.ca/>

³⁴ <http://www.usask.ca/wcvm/>

³⁵ <http://www.vet.ucalgary.ca/>

³⁶ <https://www.medvet.umontreal.ca/index.html>

“Our data show that veterinarians tend to practice close to where they went to school. If Ontario wants to continue to have access to the veterinary expertise it needs to meet its animal and human health needs, a strong Ontario-based veterinary school is essential.”– Doug Raven, Chief Executive Officer Ontario Veterinary Medical Association

Table 16: Geographical distribution of OVC graduates

Cohort	Number of Respondents	Working in Ontario	Working Outside of Ontario
2009	70	80%	20%
2010	65	73%	27%
2011	72	81%	19%
2012	73	72%	28%
Average percentage	-	76%	24%

The Province of Ontario’s regional analysis of veterinarian employment shows an employment pattern that is different than most occupations as there is less concentration in the Toronto area. Only 32% of veterinarians are located in Toronto (an area predominantly associated with companion animals) versus an average across all occupations of 45%.³⁷ Furthermore, an analysis of the distribution of veterinarians across Ontario shows clustering around the major food production centres such the Kitchener – Waterloo – Barrie region, which contains 18% of all veterinarians versus the average across all occupations of 10%, and the Muskoka – Kawartha region that contains 7% versus an average of 3%.³⁸ This highlights that while the number of veterinarians are focused on companion animals is significant, the number of veterinarians in high-value agricultural areas of the Province is also significant.

Employment

There is almost no unemployment across veterinary medicine and recent government of Canada outlook shows a projected growth in demand for veterinarians in the future. Furthermore, more than 44%³⁹ of veterinarians are self-employed meaning that they themselves create economic impact in the province based on their spending and hiring activities.

Summary

OVC trains almost one-third of the veterinarians in Canada. If OVC did not continue in its current role, there would be significant concerns as to whether the other veterinary colleges across Canada could make up the shortfall in veterinarians. Based on current demand trends for veterinarians in Canada, as well as high employment levels in the profession and the fact that veterinary graduates predominantly choose to live in the region where they were educated, Ontario’s ability to attract veterinary professionals from other Provinces or countries could be a significant challenge.

³⁷ http://www.tcu.gov.on.ca/eng/labourmarket/ojf/pdf/3114_e.pdf

³⁸ http://www.tcu.gov.on.ca/eng/labourmarket/ojf/pdf/3114_e.pdf

³⁹ http://www.servicecanada.gc.ca/eng/qc/job_futures/statistics/3114.shtml#stats

6. Conclusion

The objective of this study was to analyze the economic and socio-economic impact that OVC and associated activities have on Ontario and, furthermore, to identify the true need for veterinary medicine, and by association OVC, to the Province of Ontario.

Economic Impact:

- *Local Economic Impact:* The local economic impact on Ontario from OVC operations is estimated to exceed \$125 million per annum and have an employment impact of more than 800 jobs per year amounting to \$43.6 million in total employment income.
- *Clinical Practice of Veterinary Medicine in Ontario:* Veterinarians contribute an additional estimated \$1.3 billion of economic activity in the Province from their practices.
- *Veterinary Support of Critical Industries:* Veterinarians play a significant role in the support of the \$20 billion of economic activity that are estimated to result from food animal production in the Province.

Impact of Health Management Activities & Research and Innovation at OVC:

- *Food Animal Health Management:* The management of the health of the food animal population is critical to maintaining the economic viability and sustainability of Ontario's food production industry and the OVC is an essential link in the development and maintenance of health management standards and protocols in an ever-evolving landscape.
- *Public Health and Zoonoses:* The OVC plays a key role in the protection of public health in Ontario through collaboration with a number of local, provincial and federal government agencies and departments across the public health community. The OVC does significant research into zoonotic pathogens and the diseases they cause and food safety, identifying risk factors and how to manage them, with particular emphasis on antimicrobial resistance. These functions, along with the management techniques they develop and implement to prevent outbreaks make the OVC an essential resource to the public health field and for the people in Ontario.
- *Translational Medicine:* Translational medicine is an essential tool in disease diagnosis, treatment and prevention and research in both people and animals. The OVC is as a hub for this discovery in Ontario and across Canada. This role is possible because of the OVC's strategic positioning because the access it has to several million people and their animals, giving it an excellent opportunity for studies and clinical trials. Furthermore the OVC is continuously partnering with other institutions and industry to conduct studies and develop new knowledge to improve the health of animals and people.

Impact of Short and Long-Term Veterinary Medicine Needs:

- There is almost full employment for veterinarians and recent government of Canada outlook show a projected growth in demand for veterinarians in the future. In addition, the purview of veterinary medicine is continually expanding, with more veterinarians providing their expertise to various disciplines within the public health field. These factors would indicate that the long-term demands for veterinarians will remain strong into the future.

The Importance of OVC:

- The OVC directly contributes more than \$125 million in economic activity from its operations. The OVC through its research, faculty and graduates support industries that contribute approximately \$20 billion to Ontario's economy.
- Furthermore a significant portion of OVC graduate veterinarians own and operate private practices, which have an economic impact of approximately \$1.3 billion from their operational activities.
- The development of veterinarians is critical to the food production value chain and without OVC there would be significant concerns as to the continued support of these industries in Ontario.

There is currently a finite capacity to train veterinarians in Canada, extremely high employment levels for the profession and most veterinarians practice in their home province or the Province in which they obtained their training. Without developing and training veterinarians in the Province of Ontario, the Province may have a significant challenge in recruiting veterinarians to the Province.

- In addition to training veterinarians, OVC plays a critical role in disseminating research to industry and is a vital link in the public health community ensuring health issues are tackled from both a human and animal perspective. .

Appendix A - Industry Background

Veterinary Medicine

Veterinary medicine plays an important role across the globe in terms of both the health of animals and people, as well as the economic stability of the regions where animals serve as food production animals or companion animals, as well as regions with high numbers of horses, such as horse-racing and performance horses.

From Ontario's perspective, veterinarians are involved in food animal health and production, companion animals and horses, public health and government, and animal-related industries. Veterinarians play an important role whether they are maintaining the health of the animals involved, developing translational medical research to help improve the health of animals and people or monitoring infectious diseases and ensuring that sufficient protocols are in place to deal with animal and food safety related public health issues.

Food Animal Production Industry Overview

In 2012, the agriculture and agri-food system directly provided one in eight jobs in Ontario, of which more than 52,000 were employed in animal production activities.⁴⁰ There are three major food animal production sectors that make up a substantial portion of this impact.

Dairy

The dairy industry provides approximately \$1.9 billion annually and accounts for approximately 19% of the province's agricultural production. In 2012, the 4,029⁴¹ dairy producers in Ontario owned 315,000 milk producing cows and produced 2.6 billion litres of milk.⁴²

Poultry

The poultry industry across Canada produces poultry products worth \$3.8 billion. In Ontario alone, there are more than 1,000 independent farms that produced more than 212 million birds in 2012 with a total value of more than \$920 million dollars, as well as almost 3 billion eggs valued at approximately \$400 million and accounting for 40% of total egg production in Canada.

Swine

The swine industry in Ontario consisted of approximately 1,600 pork producers that marketed approximately 4.9 million pigs in 2012 and contributed \$5.6 billion to the provincial economy.⁴³

Companion Animals and Equine

Companion Animals

Canadians spend approximately \$4 – \$5 billion a year on their pets⁴⁴ which can be equated to between \$1.5 and \$2 billion in Ontario. In a recent Statistics Canada Survey, it was estimated that nearly half of all Canadians were pet owners. The proliferation of pets is highlighted with 38% of the households owning cats and 35% owning dogs⁴⁵. A 2009 Statistics Canada survey estimated that the annual average spend by pet owners for veterinary and other services was \$2,149 and for food was \$3,296. The role of companion animals in Canadian society is significant and the industry that has developed around companion animals has also grown. Although there are no recent statistics the companion animal industry was estimated to support approximately 40,000 jobs in 1998⁴⁶ and this number would have grown considerably since that time.

⁴⁰ Employment in Selected Agri-food Industries, Ontario, 2006-2012

⁴¹ Dairy Producers by County 2006 - 2012

⁴² www.milk.org

⁴³ 2012 Pork Industry Profile – provided by OVC

⁴⁴ <http://www.gdsourcing.com/StatsPacks/StatsPack-Pets.asp>

⁴⁵ <http://www.gdsourcing.com/StatsPacks/StatsPack-Pets.asp>

⁴⁶ <http://www.pamperedpaws.com/statistics.php>

Equine

There are almost 380,000 horses on over 48,000 facilities across Ontario with an annual economic impact of \$675.5 million and a total economic impact in fixed assets of \$6.9 billion.⁴⁷ The horse industry in Canada contributes more than \$19 billion annually to the Canadian Economy with on-farm activities generating 76,000 full-time jobs and off-farm activities such as racing and competitions generation over 9,800 full-time jobs. In total, the Canadian horse industry supports 154,000 jobs.⁴⁸

Public Health

“Most people think of veterinarians as doctors who treat cats and dogs. While veterinarians do cure, offer advice, and assess the well-being of cats and dogs, as well as numerous other animals, their role is substantially broader and isn’t limited to animal health”⁴⁹ Public Health is an essential sector and deals with the prevention of disease, the promotion of health and the prolonging of life for the people of Ontario. As such, and due to the close relationship that the human population and animal population share, it is important that the animal side of the health continuum is considered when addressing public health issues.

*“When solving complex health issues it is important to consider all aspects that could impact our health from pathogens to host animals (domestic or wildlife), to people, and to the environment”
Dr. Claire Jardine, Ontario Veterinary College*

Because of this need to incorporate considerations around animal impacts when dealing with Public Health, veterinarians now play a much more active role in the public health industry.

Impact of Animals in Society

Production Animals

The value of the production animal industry in Ontario is significant both in terms of economic impact and the provision of employment, but also in terms of Ontario being able to have a secure and diverse food supply. The complex nature of the food supply value chain and the integration of farm production sites close to human population centers bring unique challenges regarding disease control. The following are some key issues:

- Food Supply Chain – In order to ensure the continued supply of food to the people of Ontario, veterinarians must work to maintain the health of food production animals and thus protect the food supply chain. An example of what happens when this protection breaks down can be seen right now in the US where Porcine Epidemic Diarrhea has killed over 1 million piglets⁵⁰, seriously impacting the pork supply to those states affected. Impacts to food supply create higher costs for consumers and can damage export sales of the province’s food products.
- Pathogens passing from animals to humans and vice versa – Over sixty per cent of new and emerging infectious diseases are transmitted between animals and humans⁵¹. This, and the fact that production animals live in close proximity to significant populations, creates unique issues for the public health agenda in the province, including “SARS” (severe acute respiratory syndrome), “pandemic flu” and West Nile virus, and mad cow disease (bovine spongiform encephalopathy). The complexity of these pathogens and the nature of infections require expertise from both the animal and human perspective.

Companion Animals

Pets are integrated in almost every second household in Canada and generate significant economic spend in the economy. The integration of pets in society also creates unique demands on the Public Health sector because of diseases that have zoonotic significance.

⁴⁷ http://horse.on.ca/wp-content/uploads/2011/10/Economic-Impact-of-the-Ontario-Horse-Industry-Feb_08-.pdf

⁴⁸ http://horse.on.ca/wp-content/uploads/2011/10/Economic-Impact-of-the-Ontario-Horse-Industry-Feb_08-.pdf

⁴⁹ Excerpt from The Future of Veterinary Medicine complete citation?

⁵⁰ <http://bulletin.ovc.uoguelph.ca/post/74742099510/infectious-disease-experts-in-the-news>

⁵¹ http://www.uoguelph.ca/news/2008/05/post_110.html

Equine

The equine industry is a significant industry and ranges from individuals who own horses for simple pleasure riding to those who jump or race horses. The horse racing industry in Ontario alone sees approximately \$800 million wagered on it on annually, and the industry makes significant investments in the breeding, training and racing of horses. Due to this investment and the level of economic activity in the industry, the roles of veterinarians and the equine specialists at Guelph are key supports to the industry.

Appendix B - Ontario Veterinary College

History

OVC is the oldest veterinary college in Canada and the United States, educating veterinarians since 1862, and was a founding college of the University of Guelph in 1964. Its graduates are often sought after to work in areas such as clinical practice, food safety, public health, and ecosystem health across the globe.

Current State

OVC is committed to improving the health of animals, humans and the environment and its vision is to be “A world leader, integrating animal, human and environmental health through innovation, excellence and societal relevance.” Its mission is to “Educate veterinarians and scientists, create new knowledge and provide expert services to improve the health and well-being of animals, people and the environment.”

OVC has a number of educational programs designed to cover the full suite of educational requirements that modern day veterinarians must meet.

Doctor of Veterinary Medicine

The OVC's four-year professional Doctor of Veterinary Medicine (DVM) program educates students “to think in new ways, to understand the connection between animal health and its enormous impact on human health, and to develop an understanding of the important leadership role they can have within our communities.”⁵² With the ever-evolving demands placed on practicing veterinarians, the DVM curriculum needs to be as diverse as the job opportunities for students after they graduate. The three competency domains of the OVC DVM program are Planning and Analysis, Professionalism and Conducting Veterinary Activities and together they are designed to best prepare its graduates for a role that requires knowledge, skills and attitudes to examine aspects of the health where animals, humans and the environment intersect.⁵³ This training prepares DVM graduates to enter the workforce in a number of different sectors dealing with production animals, companion animals, the pharmaceutical industry, public health to name a few.

The OVC has full accreditation from the American Veterinary Medical Association and the Canadian Veterinary Medical Association. This means that OVC graduates are eligible to take the North American common licensing examination and then any state or provincial licensing exam. Without accreditation, OVC would be severely hampered in its ability to recruit outstanding faculty and students and the reputation of the College, the university and the province would be damaged.

Jointly Offered Programs and Graduate Studies

The OVC also offers BSc degrees in Biomedical Sciences and Toxicology jointly with other colleges at the University of Guelph as well as a number of graduate programs including graduate diplomas, MSc, Master of Public Health (MPH), Master of Biomedical Sciences (MBS), PHD, and Doctor of Veterinary Science degrees. Finally, the College offers clinical specialist-in-training programs and Summer Leadership and Research Programs for students in its DVM and BSc programs.

⁵² Excerpt from The Future of Veterinary Medicine

⁵³ <https://ovc.uoguelph.ca/sites/default/files/users/ovcweb/files/The-Competency-Domains-of-the-OVC-DVM-Program.pdf>

Funding

Base funding for the OVC comes from the Ontario Ministry of Training, Colleges and Universities (MTCU) and the Ontario Ministry of Agriculture and Food and Rural Affairs (OMAFRA), including the Veterinary Clinical Education Program (VCEP). Research funding is expanding, with external funding from the Natural Sciences and Engineering Research Council, the Canadian Institute of Health Research, the Canadian Foundation for Innovation and the Canada Research Chairs program.

There is also a large percentage of OVC funding that comes directly from industry, including animal health companies and commodity organizations, and from donations to OVC, OVC Pet Trust Fund, and Equine Guelph. In fact, between the years of 2005 – 2014, donations to the OVC constituted 31% (\$57M) of the “New Activity (New Gifts and Pledges)” donation to the University of Guelph. This ability of the OVC’s programs to leverage public sector funding with large private sector funding/grants/ donation helps OVC to increase the scale of programs and the positive impact to farmers, industries and taxpayers.

Academic Departments

Biomedical Science

The Department of Biomedical Sciences provides unique opportunities for translating fundamental research into practical applications that enhance animal and human health. Its expertise spans several disciplines including biomechanics, cancer biology, endocrinology, neuroscience, pharmacology and toxicology, and reproductive biotechnology. In addition to providing DVM students with a solid grounding in basic science, it offers a thriving graduate studies environment and contributes to BSc degree programs in Bio-Medical Science and Toxicology.

Clinical Studies

The Department of Clinical Studies provides undergraduate and graduate-level training and research in areas related to clinical veterinary medicine including surgery, cardiology, neurology and internal medicine. It is dedicated to the health and well being of companion animals (dogs and cats as well as birds and exotic species), performance animals (primarily horses) and individual food-producing animals. It offers advanced clinical training for DVM graduates leading to board certification in specialties ranging from anesthesiology to surgery.

Pathobiology

The Department of Pathobiology is dedicated to the advancement of knowledge in veterinary and comparative pathology, infectious diseases and immunology. Its faculty members’ research and graduate training ranges from the basic understanding of the mechanisms of disease caused by a wide range of agents (including emerging and zoonotic pathogens), to the different protective and pathological responses to host organisms. It offers advanced training in diagnostic anatomic and clinical pathology.

Population Medicine

A healthy human population needs safe supplies of food and water and a healthy environment. The Department of Population Medicine is an international leader in promoting health and productivity in animal populations. Through its teaching and research, it promotes food animal health management and helps protect public health by ensuring food safety and promoting ecosystem health, with an emphasis on the prevention and control of zoonoses and other diseases in domestic animal populations.

Initiatives

Centre for Public Health and Zoonoses

A collaborative and multidisciplinary approach is necessary to address public health challenges at the human-animal-environmental interface. The Centre for Public Health and Zoonoses (CPHAZ) was established in 2006 to recognize and build on the strong tradition of public health research and education at the University of Guelph and, in particular, its role is to coordinate existing public health research at the University of Guelph, create and support working relationships between researchers across disciplines,

and advance education related to Zoonoses and public health. It specifically deals with the production of a safe and abundant food supply, prevention and control of Zoonoses, eco-system health, and comparative animal research. Methodological research approaches range from the molecular to the population-level and extensive collaborations across disciplines, and with numerous animal health and public health organizations, allow this collective to address complex topics and to disseminate results to a broad range of stakeholders.

Institute for Comparative Cancer Investigation

Launched in 2007, the Institute for Comparative Cancer Investigation (ICCI) at the University of Guelph is dedicated to providing comprehensive cancer care for companion animals and unlocking the deadly secrets of the disease for the benefit of all species, including humans. The institute is the first of its kind in Canada, combining OVC's expertise in basic cancer biology and veterinary medicine to take an integrated approach to cancer studies that cannot be matched in a human health care environment. It coordinates collaborative research from more than 30 cancer investigators, from at least a dozen departments across the university: cancer biologists, veterinarians, chemists, mathematicians, computer scientists, toxicologists, psychologists and others who represent Guelph's unique capacity to broaden the scope of research and deepen our understanding of cancer. A key component of this groundbreaking initiative is the establishment of a world-class Mona Campbell Centre for Animal Cancer. The centre is dedicated to cancer diagnosis, treatment, teaching and clinical and translational research.

OVC Pet Trust Fund

As Canada's first charitable fund entirely dedicated to advancing the health and well-being of companion animals, the OVC Pet Trust Fund (PTF) honours the relationship between pets, their people and veterinary care givers. It does this by raising funds and supporting learning, healthcare, and research at OVC. Since its establishment in 1986, the PTF has raised millions of dollars through the generosity of friends and supporters. Funding from the PTF has led to major improvements in anesthesia and pain control for pets, heart disease and heart monitoring techniques, cancer diagnostics and treatment, understanding the human-animal bond and more.

Campbell Centre for the Study of Animal Welfare

In 1989, the Centre for the Study of Animal Welfare (CCSAW) became the first centre of its kind in North America and the second in the world. The centre's mission is to promote the welfare of animals through research and education, a mandate that it achieves by offering public lectures, seminars, and educational opportunities for people interested in animal welfare.

Appendix C - Interviews Conducted

Ontario Veterinary College

- Dr. Anthony J. Mutsaers – DVM, PHD, Diplomate ACVIM (Oncology)
- Assistant Professor, Ontario Veterinary College
- Dr. Paul Woods - DVM, MS, Diplomate ACVIM (Internal Medicine, Oncology)
- Professor, Ontario Veterinary College
- Dr. Brenda Coomber - BSc, MSc, PhD
- Professor, Ontario Veterinary College
- Dr. Stephen LeBlanc – BSc, DVM, DVSc
- Associate Professor, Ontario Veterinary College
- Dr. Jan Sargeant - DVM, MSc, PhD
- Professor and Director of CPHAZ, Ontario Veterinary College
- Dr. Scott Weese – DVM, DVSc., Dipl., ACVIM
- Associate Professor, Ontario Veterinary College
- Dr. Michele Guerin – DVM, MSc, PhD
- Associate Professor, Ontario Veterinary College

External

- Tim Nelson
- CEO, Livestock Research Innovation Corporation
- Dr. Victoria Edge
- Manager, Population Health Assessment Epidemiology, Public Health Agency of Canada
- Dianne Graham
- Executive Director, Ontario Equestrian Federation
- Rena Hubers
- Chief Administrative Officer/Assistant Deputy Minister, Research and Corporate Services, Ontario Ministry of Agriculture and Food
- Michael Toombs
- Director, Research and Innovation Branch, Ontario Ministry of Agriculture and Food
- Dr. Ray Reynen
- Veterinary Practitioner, Heartland Veterinary Services
- Dr. Ken Pritzker
- Chief Executive Officer, Rna Diagnostics
- Jean Szkotnicki
- President, Canadian Animal Health Institute
- Doug Raven
- Chief Executive Officer, Ontario Veterinary Medicine Association
- Keith Robbins
- Executive Director, Poultry Industry Council

Dr. Helen Anne Hudson

- Chair, Poultry Industry Council

Dr. Brian Lichty

- Associate Professor, Pathology and Molecular Medicine, McMaster Immunology Research Centre, McMaster University

Dr. Ewen Ferguson

- Veterinary Practitioner, Ferguson and Walsh Veterinary Services

Dr. Brian Evans

- Former Chief Veterinarian of Canada and the current Deputy Director General, Animal Health, Public Health and International Standards as well as Head of the Scientific and Technical Department at the World Organization for Animal Health (OIE)

www.deloitte.ca

Deloitte, one of Canada's leading professional services firms, provides audit, tax, consulting, and financial advisory services through more than 8,000 people in 56 offices. Deloitte operates in Québec as Samson Bélair/Deloitte & Touche s.e.n.c.r.l. Deloitte & Touche LLP, an Ontario Limited Liability Partnership, is the Canadian member firm of Deloitte Touche Tohmatsu Limited.

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms.

© Deloitte & Touche LLP and affiliated entities.