

Donation and transplantation

Canadian eye and tissue banking statistics 2017



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<https://professionaleducation.blood.ca/en/organs-and-tissues/tissues/data-reports-and-surveys>

2017 ETDC report foreword

Joint message: ETDC Chair and Canadian Blood Services OTDT Director

The national Eye and Tissue Data Committee (ETDC) works diligently to assemble and provide annual national reports on eye and tissue data in Canada. The 2017 ETDC report provides information that supports assessment and improvement of Canadian eye and tissue banking.

The value of the information captured has been recognized regionally, nationally, and internationally. With this information, provincial programs can assess activity trends that may be used to inform their operational strategies. National organizations, such as the Canadian Ophthalmological Society, use this data to inform discussions on national practice and policy.

We would like to express our appreciation to those who contributed to the development of this report from each contributing program, including the program representatives who directly participate in the ETDC and those who contribute to the collection, collation, validation, and submission of eye and tissue donation activity data to the committee.

Canadian Blood Services remains committed to working collaboratively with the Canadian tissue community, providing continued support for national data collection, collation, and reporting on Canadian eye and tissue banking activity.

The annual ETDC reports represent a testament to what can be achieved through inter-organizational and inter-provincial cooperation and collaboration. We look forward to continuing to work together to develop and disseminate quality information that is key to delivering a better future for Canadian eye and tissue donation.



Cynthia Johnston, BSc, CTBS, CMDRT
Chair, Eye and Tissue Data Committee
Regional Tissue Bank
Transplantation Services
Nova Scotia Health Authority



Amber Appleby, RN, BScN, MM
Director
Organ and Tissue Donation and Transplantation
Canadian Blood Services

Logan's story

Logan Boulet made the decision to be an organ and tissue donor just weeks before his passing in the tragic Humboldt Broncos bus crash in April 2018. Logan was inspired to register his decision to donate by his coach and mentor, Ric Suggit, who had died in 2017 and became a donor. After Logan registered his decision, he took the wise and necessary step of sharing his decision with his family.

The act of registering his choice and sharing that decision with his loved ones helped prepare them to make the heart-wrenching decision to allow Logan's organs and tissues to be donated for transplantation and research.

The details of this tragic event have reached a wide audience. "The Logan Boulet Effect" has inspired more than 100,000 Canadians to become registered organ donors. Logan's family continue to share their story, making an essential contribution to nationwide public awareness of organ and tissue donation.

Help us and the Boulet family spread the word about the importance of organ donation and honour Logan's legacy by taking part in Green Shirt Day on April 7 and National Organ and Tissue Donation Awareness Week, the last full week in April.

Learn more at greenshirtday.ca

Join Canada's lifeline and register your decision to donate at blood.ca/organs-tissues



Executive summary

System performance data

Beginning in 2012, Canadian Blood Services, on behalf of the Eye and Tissue Data Committee (ETDC), has received data submissions from all Canadian eye and tissue programs. Data definitions have been established and data training delivered to the Canadian eye and tissue community.

Canadian Blood Services maintains and collates data for review by the ETDC. Each year a summary report is generated. The purpose of this report is to provide information and insights into the Canadian recovery, processing and distribution of ocular and tissue allografts across Canada.

Prospective data collection was initiated in 2012. 2017 data was submitted from 16 eye and tissue banks and one recovery program representing a census of all Canadian eye and tissue banking activity (results were not available for select metrics for certain programs, as indicated). Data on allografts imported by Canadian tissue banks from the United States was available for the first time in 2016; however, data on allografts imported directly by Canadian hospitals from the United States is not readily available.

National results on key metrics

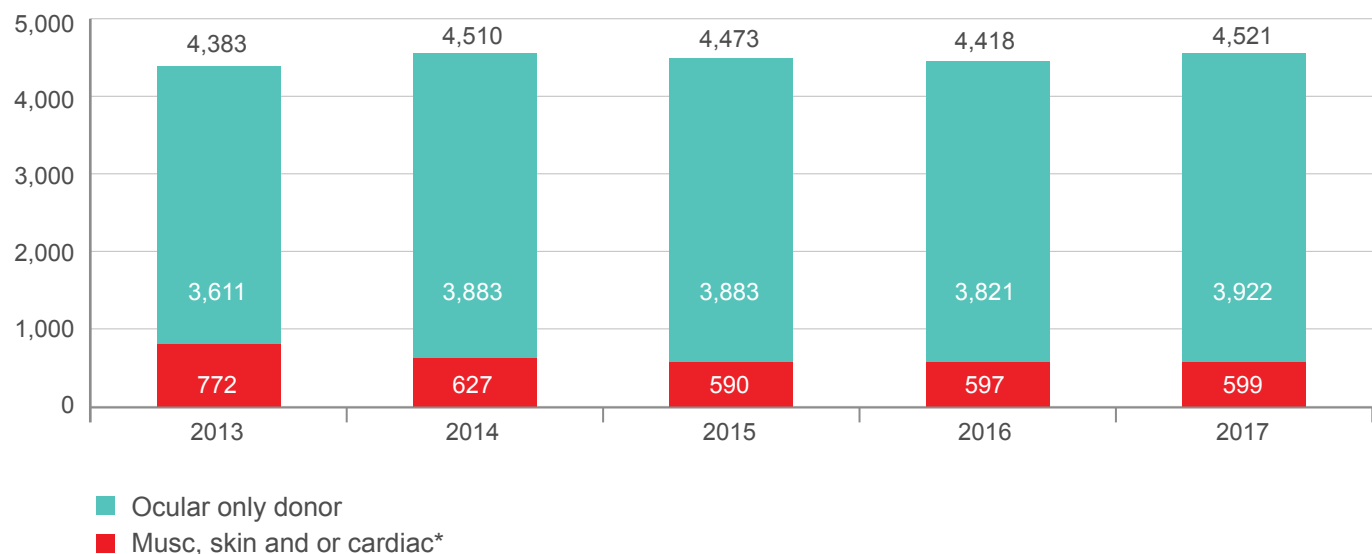
In 2017 Canadian eye and tissue banks received 50,506 deceased donor referrals for potential tissue donation, which represents an 11% increase relative to 2016; 53% of those approached consented to tissue donation, based on data from 9,057 approaches.

Although 97% of deceased donor referrals have consistently come from hospitals, hospitals are the referring agency for approximately 82% of referrals for actual deceased donors, as was the case in 2016. The second largest source (accounting for nine per cent of referrals in 2017) was extended care facilities such as nursing homes and hospices.

In 2017, tissue was recovered from 4,521 deceased donors (two per cent higher than the average for the previous four years of 4,446) and 394 living donors. The number of living donors from whom tissue is recovered continued to decline in 2017, at a rate of approximately 16% per year.

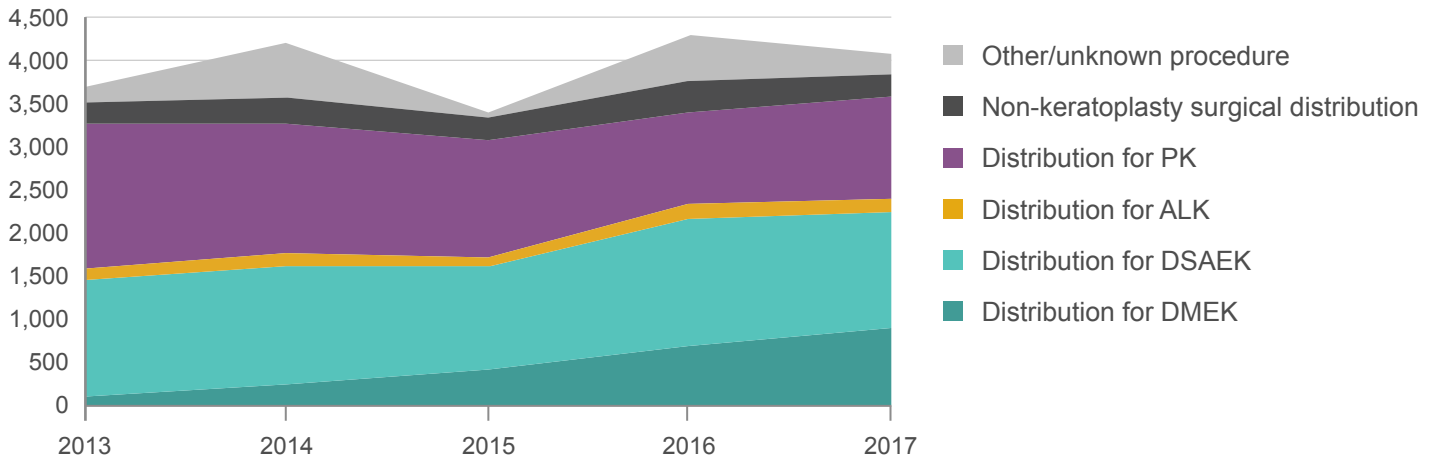
Results relating to ocular tissues in 2017 were generally comparable to 2016 results; there was a three per cent increase in the number of donors from whom ocular tissue was recovered in 2017 (n=4,391) relative to the previous year, and a three per cent decrease in ocular production for transplant, with 2017 seeing the release of 4,692 corneas for transplant.

Deceased donors by year



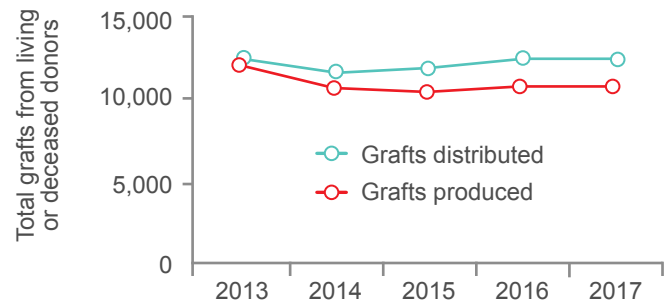
*Results include donors where ocular tissue was also recovered.

Intermediate-term preserved cornea distribution



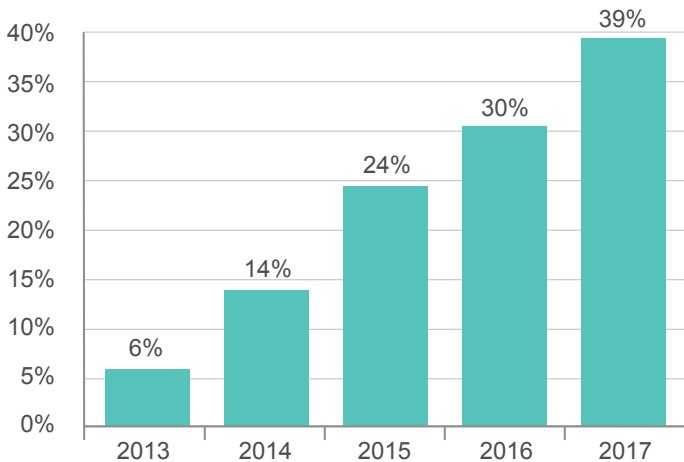
Cornea distribution for transplant, including penetrating keratoplasty (PK), endothelial keratoplasty (EK) and anterior lamellar keratoplasty (ALK) reflected comparable results to 2016 distributions, with precise differences being influenced by the number of cases in which the surgery type was not available. As was the case in 2017, eight per cent of corneas distributed for transplantation were imported from the United States.

Total musculoskeletal, skin, amnion and cardiac tissue distribution



In 2017 there were 10,928 musculoskeletal, skin, amnion and cardiac grafts produced and released to inventory nationally with 12,652 being distributed for transplant in total. The production of musculoskeletal, skin, and cardiac grafts increased by 1.4% relative to 2016, while the total number of deceased donor grafts distributed for transplant remained within 0.2% of 2016 levels.

Proportion of EK performed as DMEK



The demand for DMEK (Descemet's Membrane Endothelial Keratoplasty) continues to increase, with both the total number of corneal grafts used for this purpose and the proportion of EK procedures performed as DMEK continuing to rise.

Acknowledgments and future directions

This prospective data collection provides all jurisdictions with comprehensive analysis of tissue donation activity as well as the Canadian production and distribution of ocular and tissue grafts, documenting changes in system performance from 2013-2017. Canadian eye and tissue programs are to be commended on their leadership and their contributions to the collection and collation of system performance data. This data supports all programs and stakeholders in their valuable efforts to provide the donation and allograft services Canadians require.

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1.0 Introduction

Canadian Blood Services received a mandate from Canadian federal, provincial, and territorial governments in 2008 for organ and tissue donation and transplantation. This mandate encompasses activities that contribute to the development of leading practices, professional education, public awareness, system performance and data and analytics. Aligning with its roles relating to managing the national supply of blood, blood products, stem cells, as well as a cord blood bank and related services for all provinces and territories (excluding Québec), Canadian Blood Services leads and provides support for an integrated, interprovincial system for donation and transplantation for all of Canada.

In 2012 the Canadian tissue community directed Canadian Blood Services to facilitate the development and implementation of national data collection, analysis, and reporting on national tissue donation, production, and distribution activity. This represents a milestone in the development of systematic monitoring of Canadian tissue banking activity. To oversee the collection, management and release of national data, an Eye and Tissue Data Committee (ETDC) was established in 2012; this committee is chaired by members of the tissue community and composed of representatives from each provincial tissue program as well as Canadian Blood Services representatives (see Appendix B). The ETDC encompasses two working groups who provide insight and recommendations to the larger committee in relation to data elements, data definitions (see Appendix A), data collection, data submission, quality assurance and training, collation, analysis and release and publication.

Prospective data collection was initiated in 2012 from all eye and tissue banks operating in Canada (see Appendix C for a list of contributing programs). Canadian Blood Services acts as the repository for the collected data and provides support for data management, analytics, and publication/reporting of results, in addition to providing secretariat and administrative services for the ETDC. This cooperative effort has enabled the development of multiple published products and stakeholder presentations. Results are provided by all Canadian eye and tissue banks operating in eight out of the thirteen provinces and territories and constitute a comprehensive census of tissue banking activity, with limited exceptions. A summary of products produced and or distributed by each eye and tissue banks is detailed (see Appendix D).

The value of this data to the community was recognized and validated with the 2017 publication *“Development of national system performance metrics for tissue donation, production, and distribution activity”* in the international Journal of Cell and Tissue Banking.

The results presented report on Canadian eye and tissue banking donation, production, and distribution statistics for Canadian eye and tissue banks for January 1 to December 31, 2017 as well as Canadian system activity for 2013 through 2017. This represents the first report for which data is available for five consecutive years, allowing for insight into provincial and national trends to will inform individual tissue bank operations and strategy.

Canadian Blood Services and the Eye and Tissue Data Committee would like to express our sincere appreciation to the members of the Canadian tissue community who participate in this data collection or the time and expertise they provide to the collection and collation of national activity data.

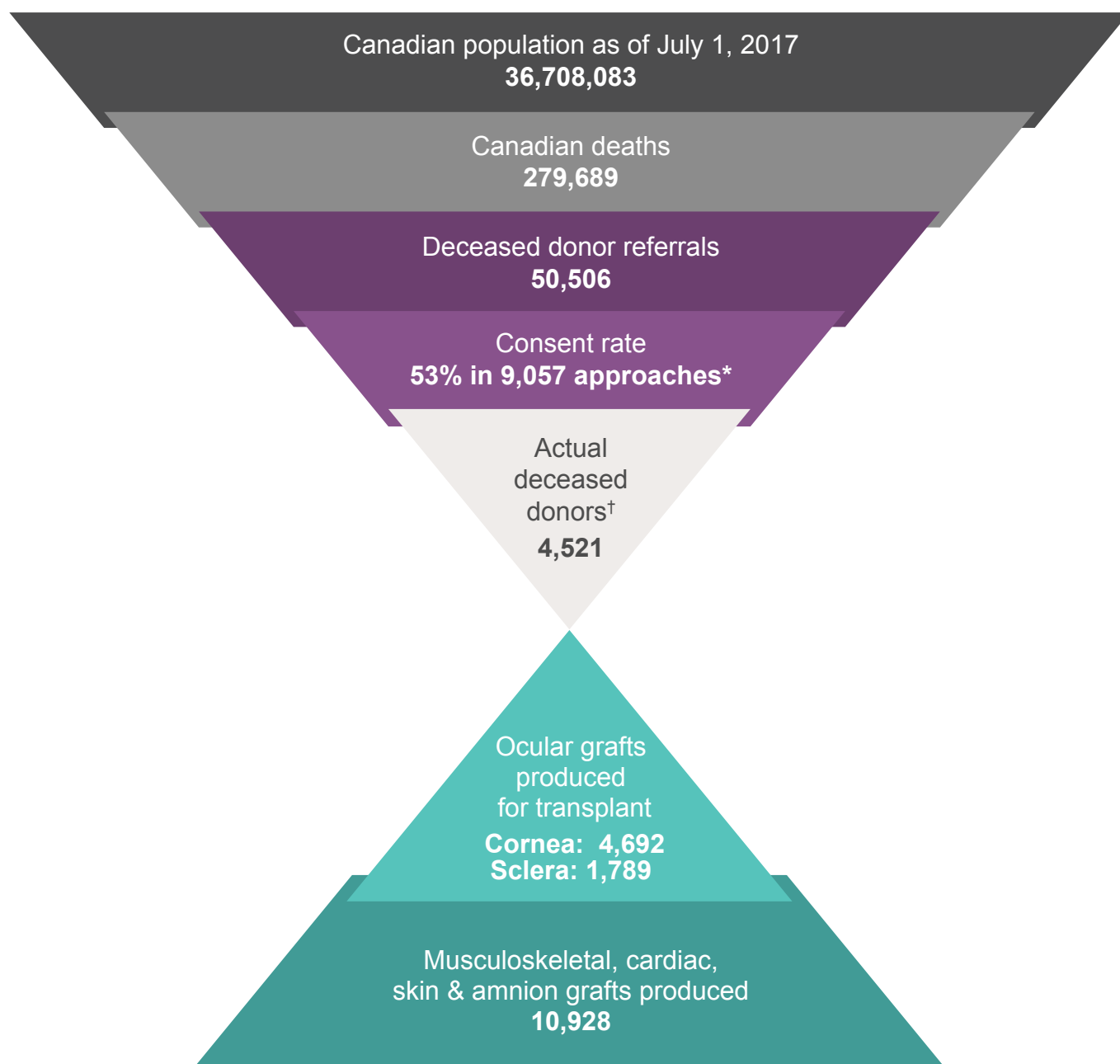


Loreen Hardy-Ramey
Cornea recipient

1.1 Canadian eye and tissue banks



2.0 2017 Canadian view of tissue donation and transplantation



Population and death data sourced from Statistics Canada. Chart adapted from the Australian Government, Australian Organ and Tissue Donation and Transplantation Authority, Annual Report 2013-2014, Figure 8: Australia's potential organ donor population.

*11 programs collect data on the number of approaches and consent rate; this data documented a 53% consent rate.

†Refers to donors from whom tissues were recovered following cardiac or neurological death. See Appendix A for definition.

3.0 Comparative analysis

3.1 Canadian eye and tissue banks

Type of bank	2013	2014	2015	2016	2017
Comprehensive tissue banks*	6	6	6	6	6
Eye banks	4	4	4	4	4
Musculoskeletal banks	3	3	3	3	3
Skin banks	1	1	1	1	1
Cardiac banks	1	1	1	1	1
Surgical bone banks*	2	1	1	1	1
Recovery	1	1	1	1	1
Total	18	17	17	17	17

*"Comprehensive" is defined as recovering and processing more than one tissue type and reporting to a common administration.

A "surgical bone bank" is defined as a bank which recovers only surgical bone. Some musculoskeletal and comprehensive banks recover surgical bone. A recovery organization provides tissue recovery services but does not process or distribute tissue.

3.2 Canadian eye and tissue banking activity

Total Canadian activity*	2013	2014	2015	2016	2017	% Change (2016-2017)
Deceased donor referrals	41,594	45,154	46,381	45,609	50,506	+11%
Total deceased donors from whom tissue was recovered	4,383	4,510	4,473	4,418	4,521	+2%
Donors where ocular tissue was recovered: includes for transplant and for research and training	4,146	4,248	4,292	4,283	4,391	+3%
Deceased donors where bone, cardiac and or skin was recovered	772	627	590	597	599	0%
Surgical bone donors	700	669	549	456	379	-17%
Total intermediate-term preserved corneas distributed to transplant – keratoplasty and unknown procedure**	3,504	3,891	3,162	3,969	3,774	-5%
Musculoskeletal, skin and cardiac grafts processed and released into inventory from deceased donors	11,297	9,709	9,856	9,731	10,032	+3%
Musculoskeletal and amnion grafts processed and released into inventory from living donors	718	1024	822	1,050	896	-15%
All musculoskeletal, skin, cardiac, and amnion grafts processed and released into inventory (living and deceased donors)	12,105	10,733	10,678	10,781	10,928	+1%
Total musculoskeletal, skin, cardiac, and amnion grafts distributed to transplantation (living and deceased)	12,605	11,740	12,119	12,632	12,652	0%
Total: All eye and tissue grafts produced and released into inventory (deceased & living donors)	17,602	16,570	16,241	17,366	17,409	0%
Total: All eye and tissue grafts distributed to transplantation (deceased & living donors)	17,820	17,131	16,595	18,650	18,315	-2%

*Some minor variation of totals from previous reports due to additional quality assurance reviews and data reconciliation.

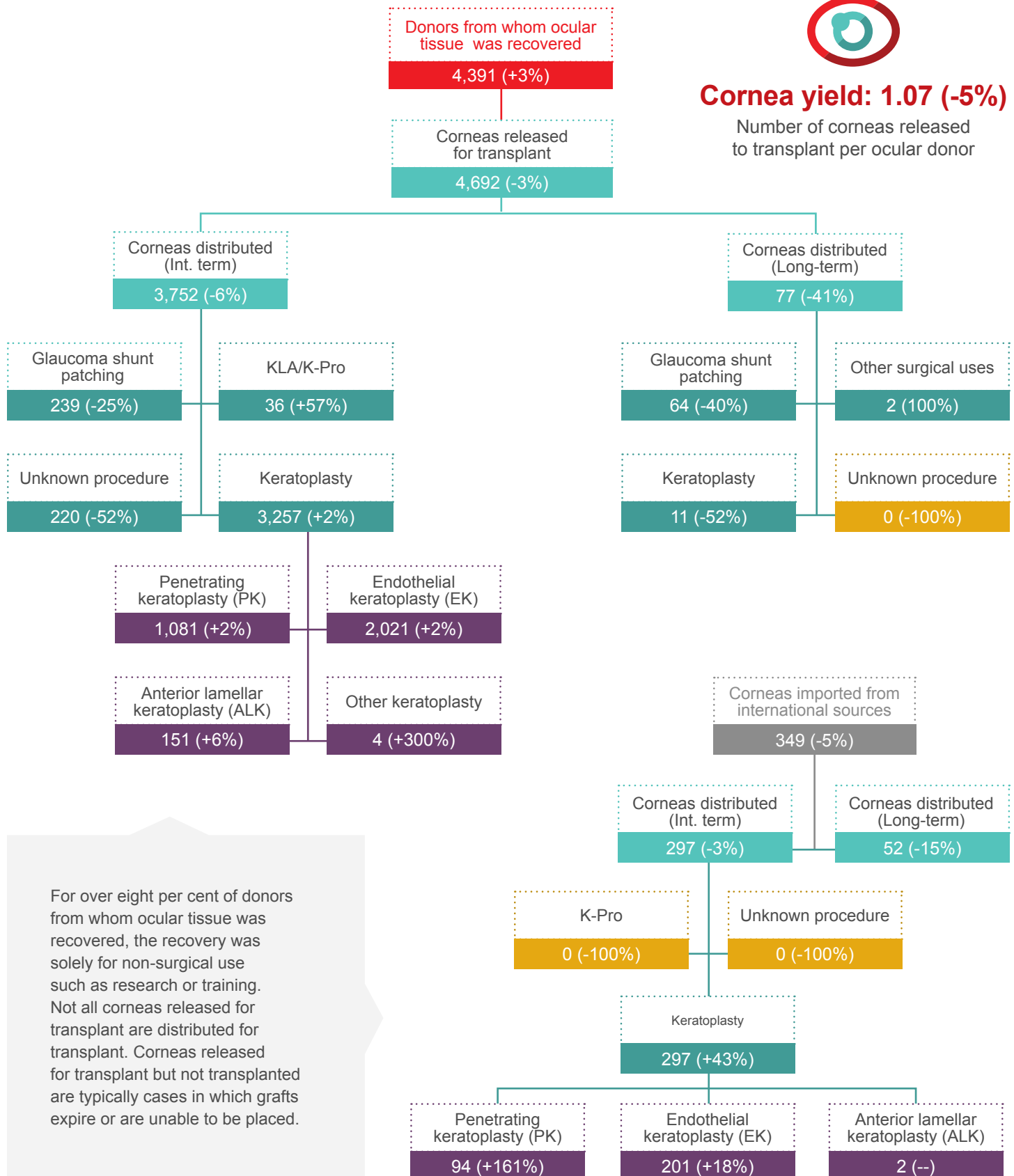
** Data limitation: In 2017, 220 intermediate-term corneas were distributed with the end use identified as "unknown" compared to 555 in 2016, 64 in 2015, 632 in 2014, and 220 in 2013. Since the majority of corneas are used for keratoplasty, cases where the end use was unknown have been included in the totals.

3.3 Cornea processing and distribution, 2017, with percentage change from 2016



Cornea yield: 1.07 (-5%)

Number of corneas released to transplant per ocular donor



For over eight per cent of donors from whom ocular tissue was recovered, the recovery was solely for non-surgical use such as research or training. Not all corneas released for transplant are distributed for transplant. Corneas released for transplant but not transplanted are typically cases in which grafts expire or are unable to be placed.

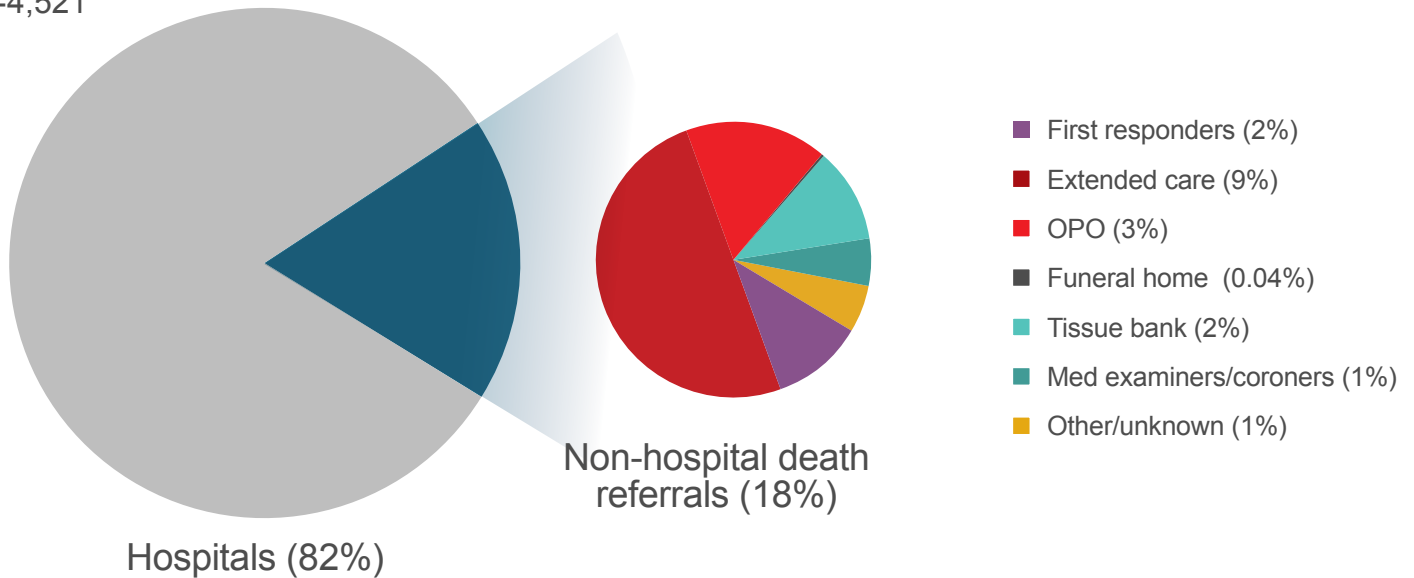
4.0 2017 Canadian eye & tissue banking deceased donation activity

4.1 Total donor referrals

A total of 50,506 deaths were identified and referred for initial screening/consideration of tissue donation potential in 2017, an 11% increase from 2016 (n=45,609) and a nine per cent increase from 2015 (n=46,381). The majority (approximately 97%) of donors have been referred by hospitals; however, approximately one fifth of realized donors in 2017 were non-hospital referrals, which is consistent with 2016 results.

Actual donors by source

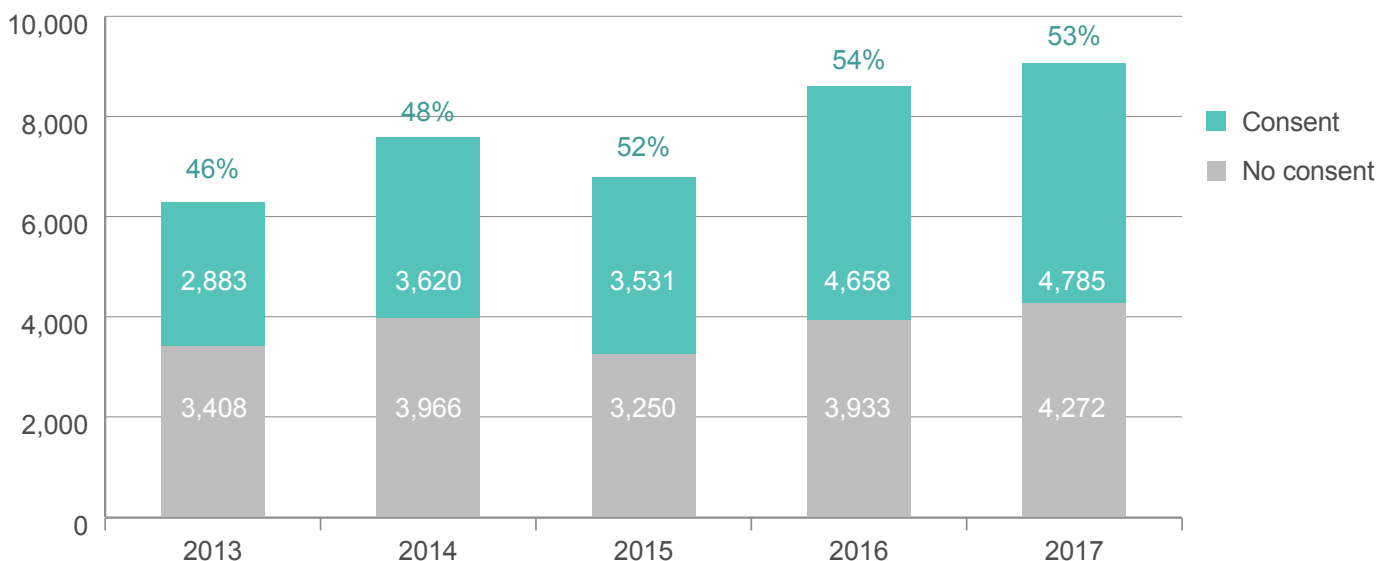
n=4,521



4.2 Consent rate

In 2017, 11 programs provided data on 9,057 approaches for deceased tissue donation. A consent rate of 53% was identified, which is on par with the consent rates in 2015 and 2016.

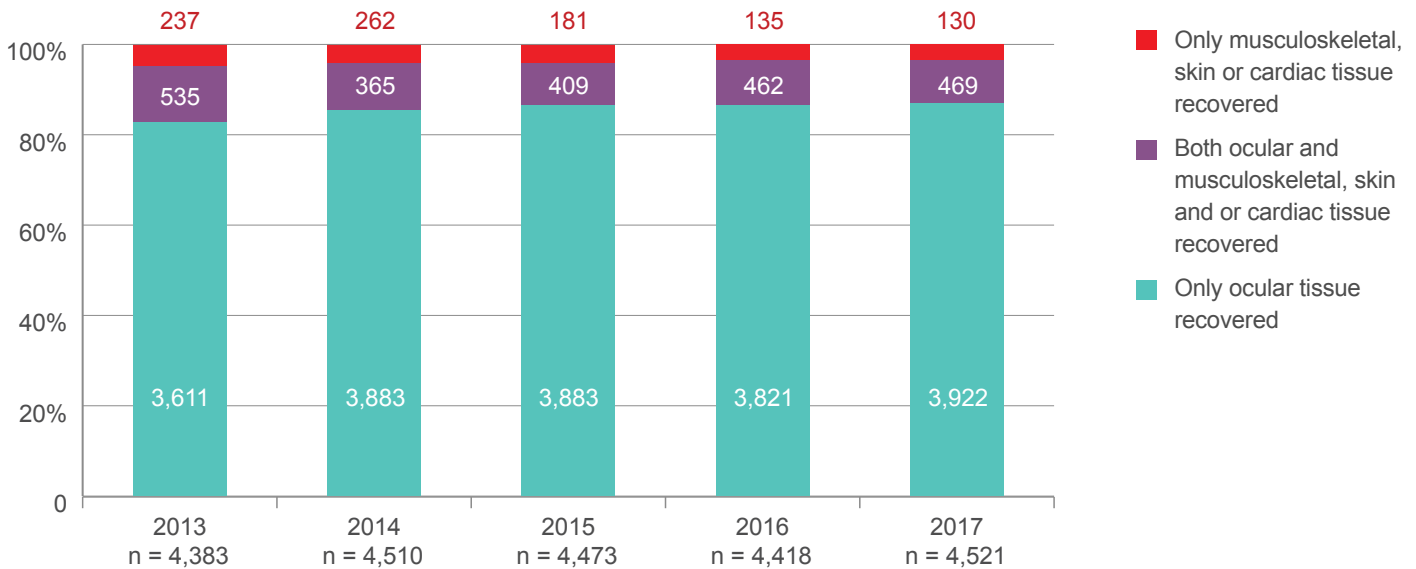
Consent rate for tissue donation



4.3 Deceased donor: national analysis

In 2017 there were 4,521 consented deceased donors from whom tissue was recovered in Canada, an increase of 2.3% from 2016 and an increase of 1.1% from 2015. 86.8% of these donors were ocular-only donors, as was approximately the case in 2015 (86.8%) and 2016 (86.5%).

Deceased donors by tissue type



Although the total number of consented deceased donors from whom tissue was recovered in 2016 represented a three-year low, the total for 2017 represents a five-year high. Nationally, year-to-year variation in deceased donors has been limited over the past five years averaging 4,461 donors per year over this period, with each year's total being within two per cent of the five-year average. The number of donors from whom ocular tissue is recovered has also remained within three per cent of the average for the past five years.

The age distributions for deceased donors in 2017 are essentially equivalent to the respective age distributions in the previous year.

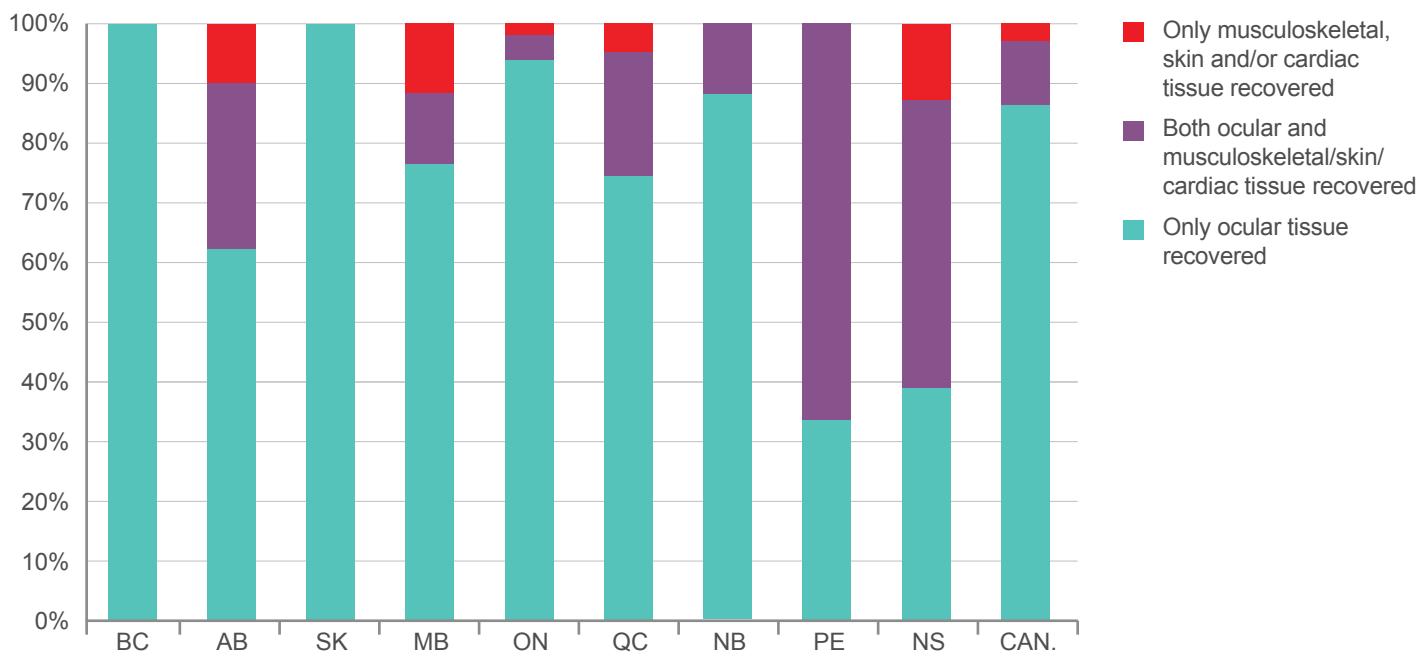
Deceased tissue donor age distribution, 2017



Age data available for 4,518 deceased donors (99.9% of total)

4.4 Deceased donor: 2017 provincial analysis

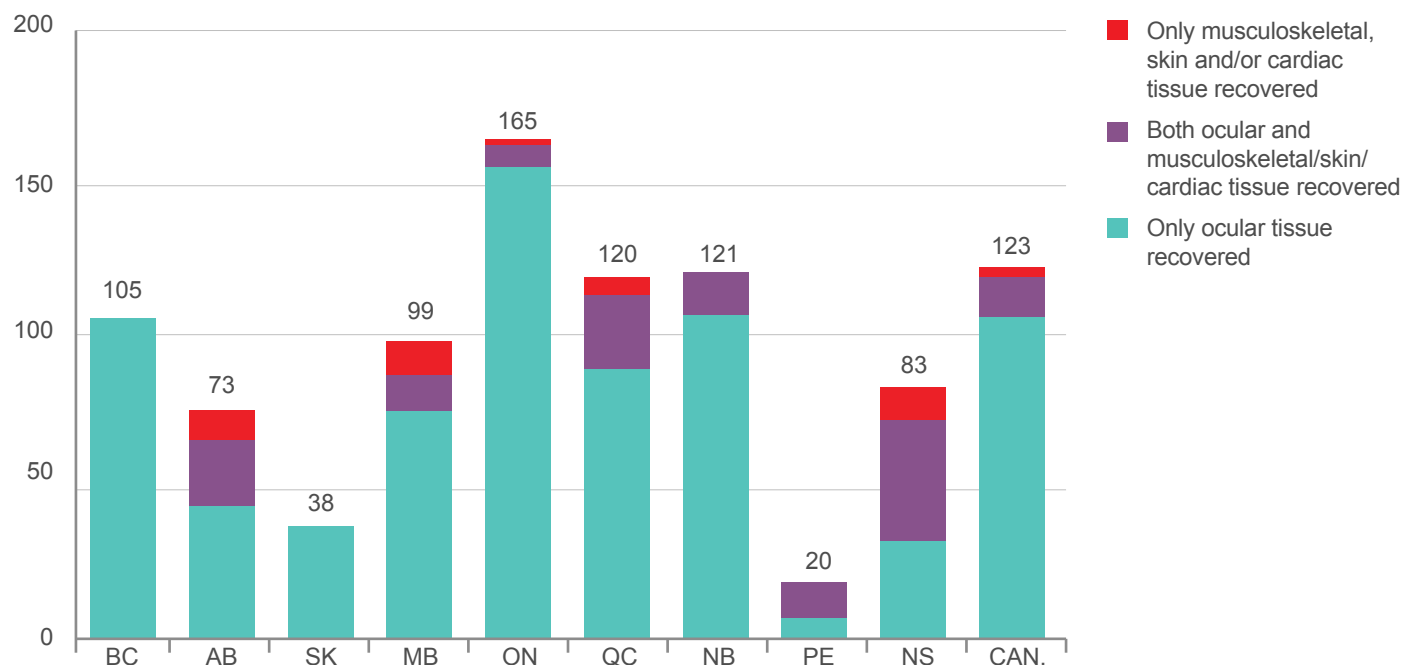
Deceased donors by tissue type recovered



PE results reflect PE donors whose recoveries were performed by the Nova Scotia program. New Brunswick donors whose recoveries were performed by the Nova Scotia program are included in New Brunswick results.

Total deceased tissue donors

Results per million population (PMP)

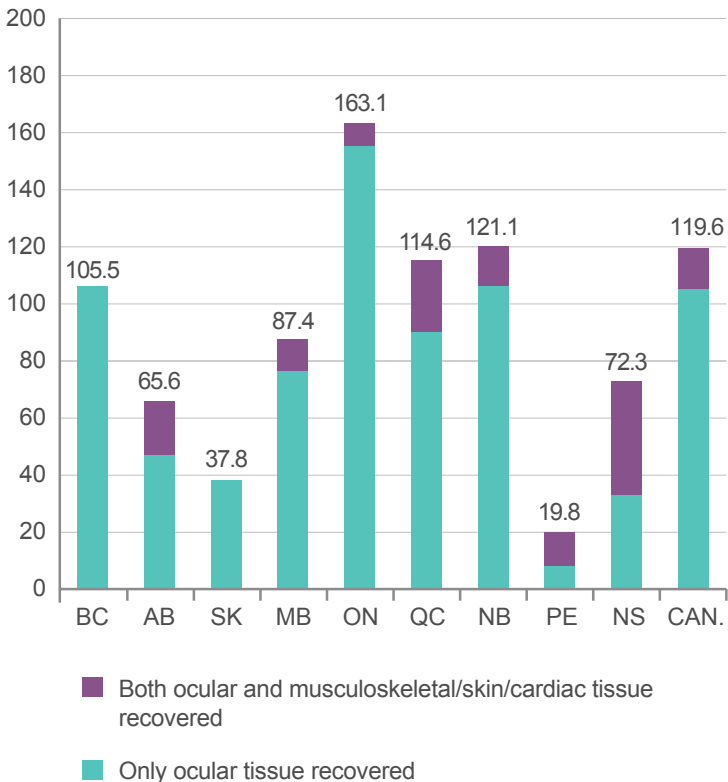


Musculoskeletal, cardiac, and skin tissue is not recovered in BC or NL. PEI results reflect PEI donors whose recoveries were performed by the Nova Scotia program. Per million population rates based on Statistics Canada population estimates by province as of July 1, 2017 (Table 17-10-0086-01). New Brunswick donors whose recoveries were performed by the Nova Scotia program are included in New Brunswick results. National rates are based on the entire national population.

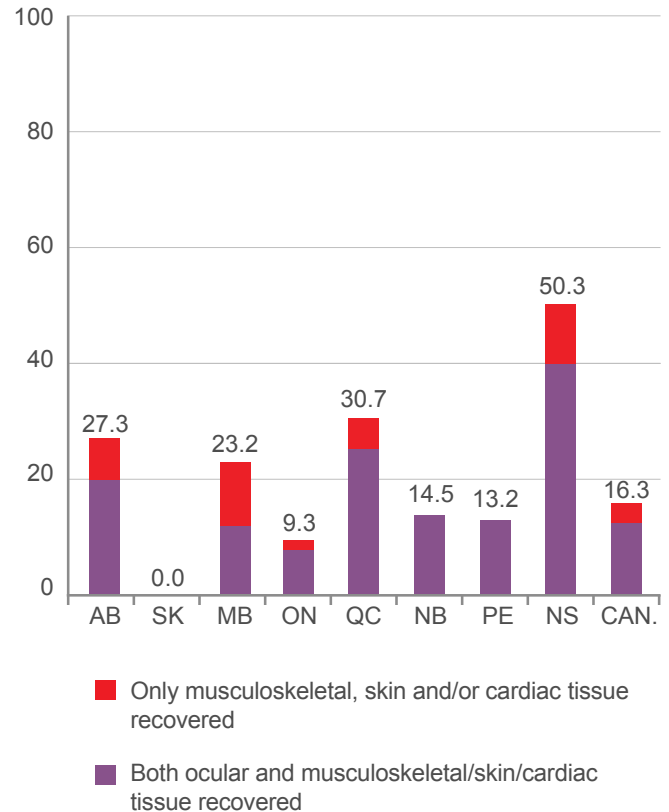
Deceased tissue donors by tissue recovered

Results per million population (PMP)

Donors from whom ocular tissue was recovered



Donors from whom musculoskeletal, skin, and/or cardiac tissue was recovered



Musculoskeletal, cardiac, and skin tissue is not recovered in BC or NL. PEI results reflect PEI donors whose recoveries were performed by the Nova Scotia program. Per million population rates based on Statistics Canada population estimates by province as of July 1, 2017 (Table 17-10-0086-01). New Brunswick donors whose recoveries were performed by the Nova Scotia program are included in New Brunswick results. National rates are based on the entire national population.



Loreen Hardy-Ramey - Cornea recipient from Arnprior, Ontario

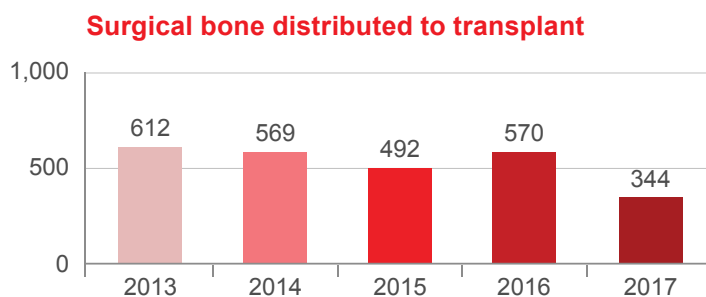
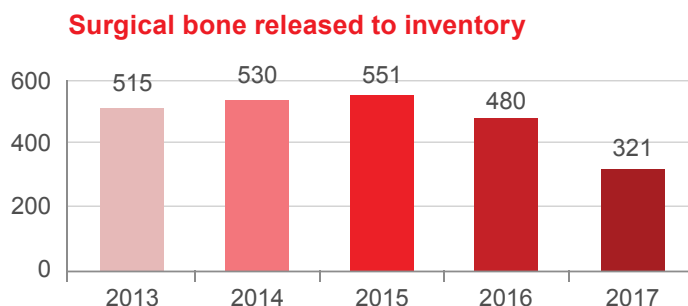
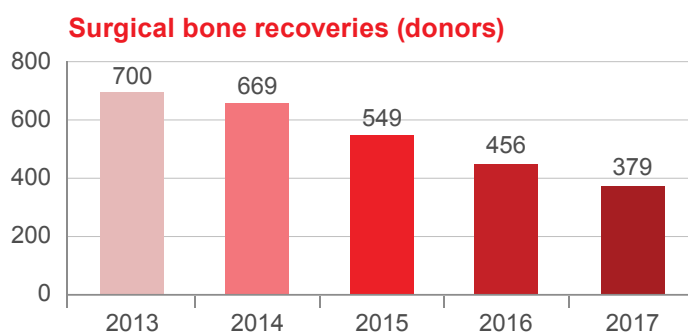
Loreen received the gift of donor endothelial tissue through DMEK surgery at the Ottawa University Eye Institute. Loreen's donor tissue continues to adhere well, her vision is improved and she no longer suffers pain in her eyes. She is deeply grateful for the priceless gift of restored vision.

Loreen is pictured here with her husband Noel.

5.0 2017 Canadian eye & tissue banking living donation activity

5.1 Surgical bone donation

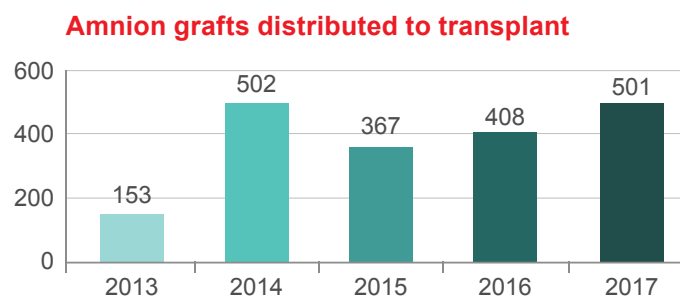
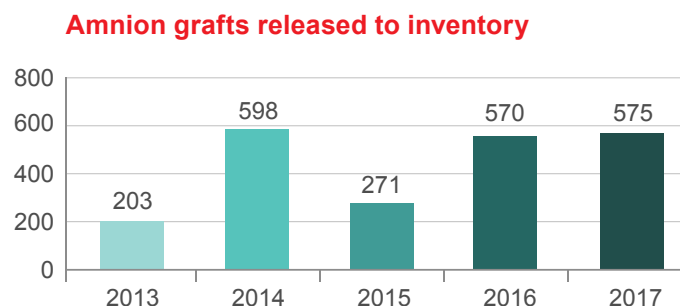
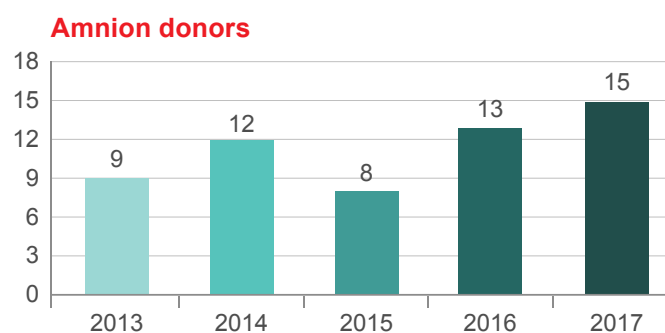
In 2017, five programs reported recovering bone from living donors; this involves recovering femoral heads during total hip replacement surgery. 2017 results suggest the ongoing continuation in the trend of decreasing living donor bone recovery, with a corresponding decrease in the number of surgical bone grafts released.



The decrease in distributions is mainly a reflection of activity in Saskatchewan, which distributed 42% fewer living donor surgical bone grafts in 2017 (n=216) than were distributed in 2016 (n=375).

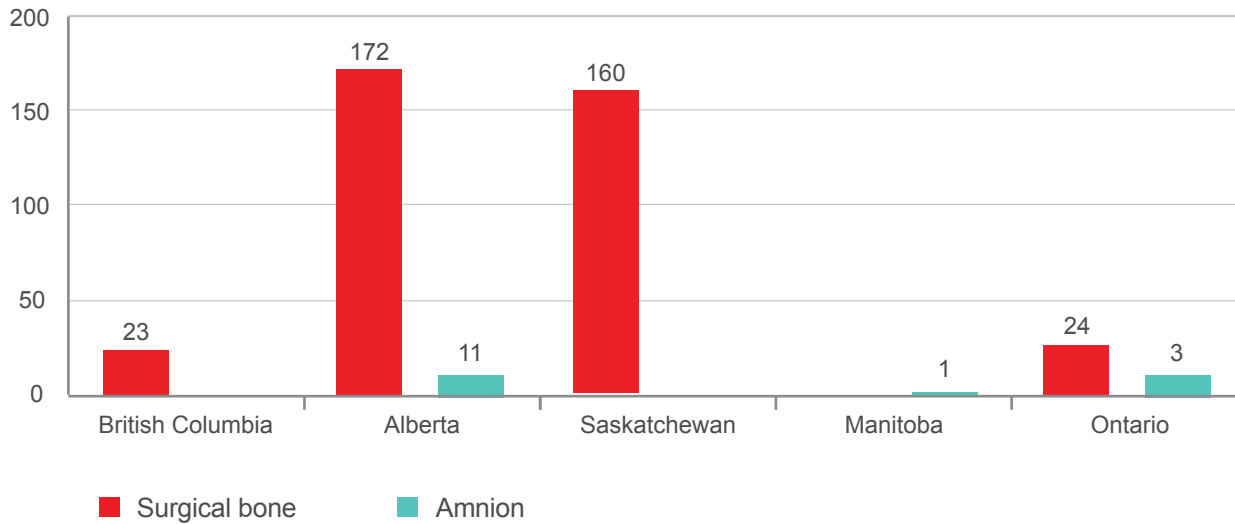
5.2 Amnion donation

Amnion living donation and production activity in 2017 is consistent with results in 2016, showing marginal increases. Distribution of amnion has increased relative to 2016, essentially reaching the distribution level in 2014.

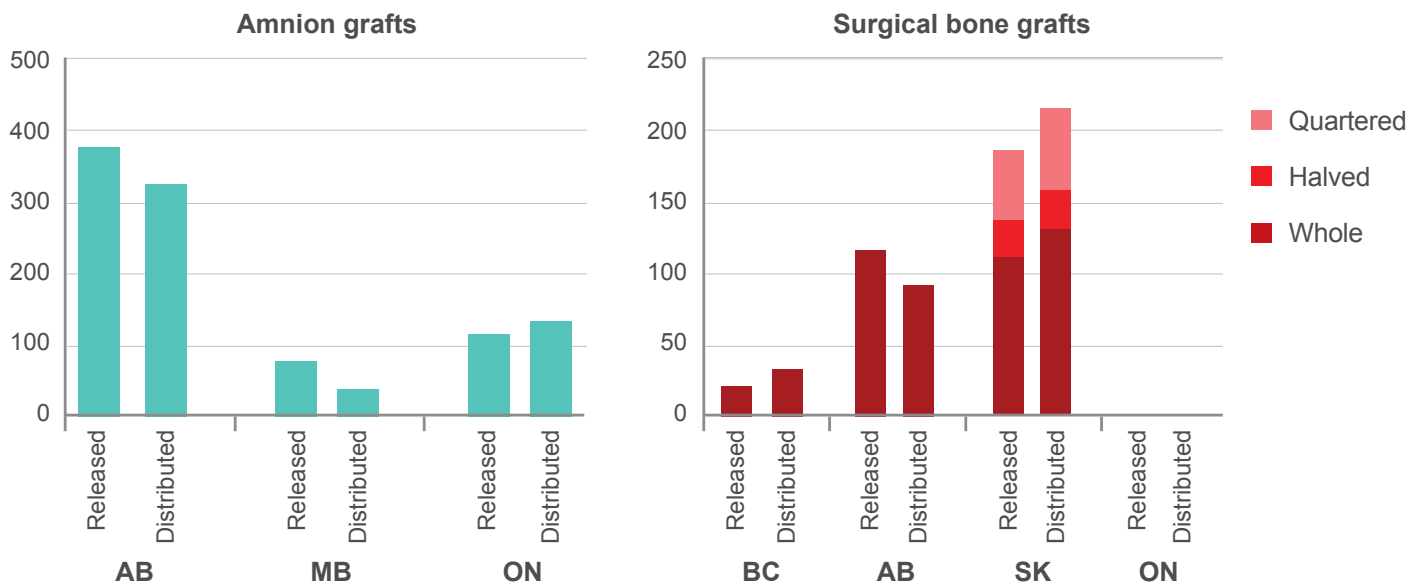


5.3 Living donation: 2017 provincial analysis

Living donors from whom tissue was recovered



Living donor surgical bone and amnion released and distributed



6.0 2017 Canadian eye & tissue production and distribution activity

6.1 Total corneas distributed for transplant

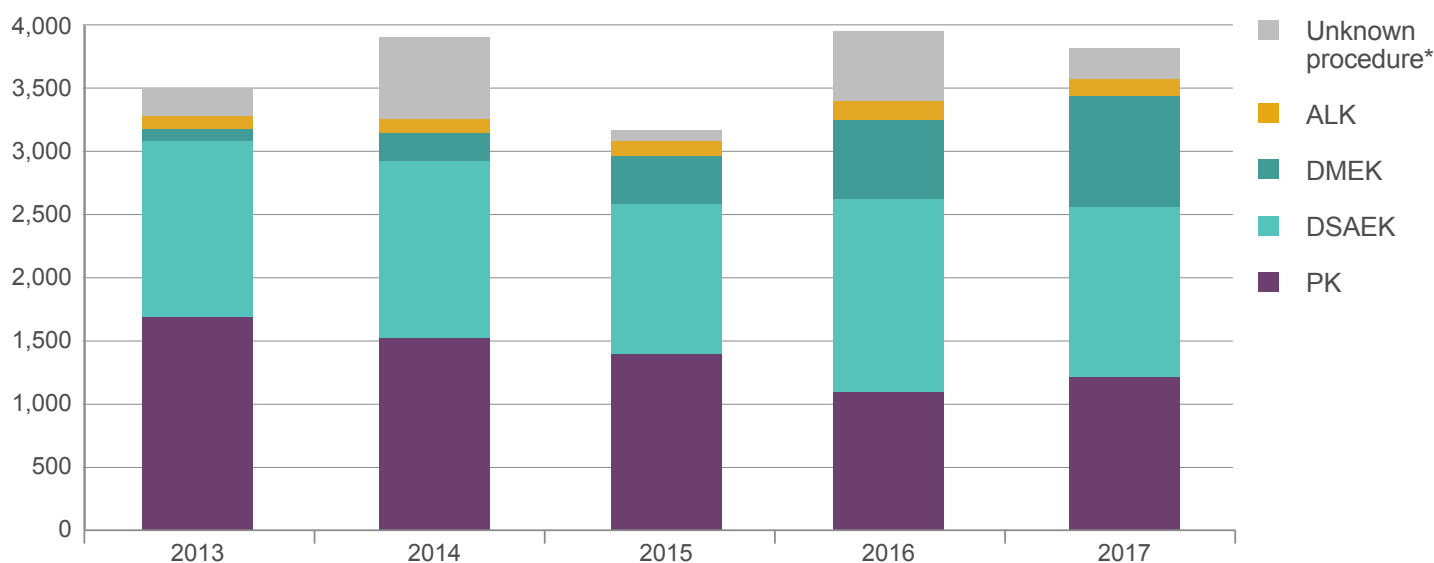
In 2017, Canadian eye banks distributed 4,178 corneas for surgical use, including 4,049 intermediate-term preserved corneas of which 3,550 were known to have been utilized for penetrating, endothelial, or anterior lamellar cornea transplant (keratoplasty).

This represents a four per cent increase from the 3,413 corneas distributed for these types of keratoplasty in 2016. Four corneas were distributed for a keratoplasty procedure other than PK, EK, or ALK in 2017. In addition, 11 long-term preserved corneas sourced in Canada were also distributed for keratoplasty, although the keratoplasty type was not available in these cases.

The final use could not be determined for an additional 220 corneas in 2017, compared to 617 corneas in 2016 (approximately six per cent of the total). It is assumed that these were used for keratoplasty, but the procedure type was not recorded.

An additional 275 intermediate-term preserved corneas were utilized in non-keratoplasty procedures including K-Pro, keratolimbus allografts, and glaucoma shunt patching.

Cornea distribution for keratoplasty



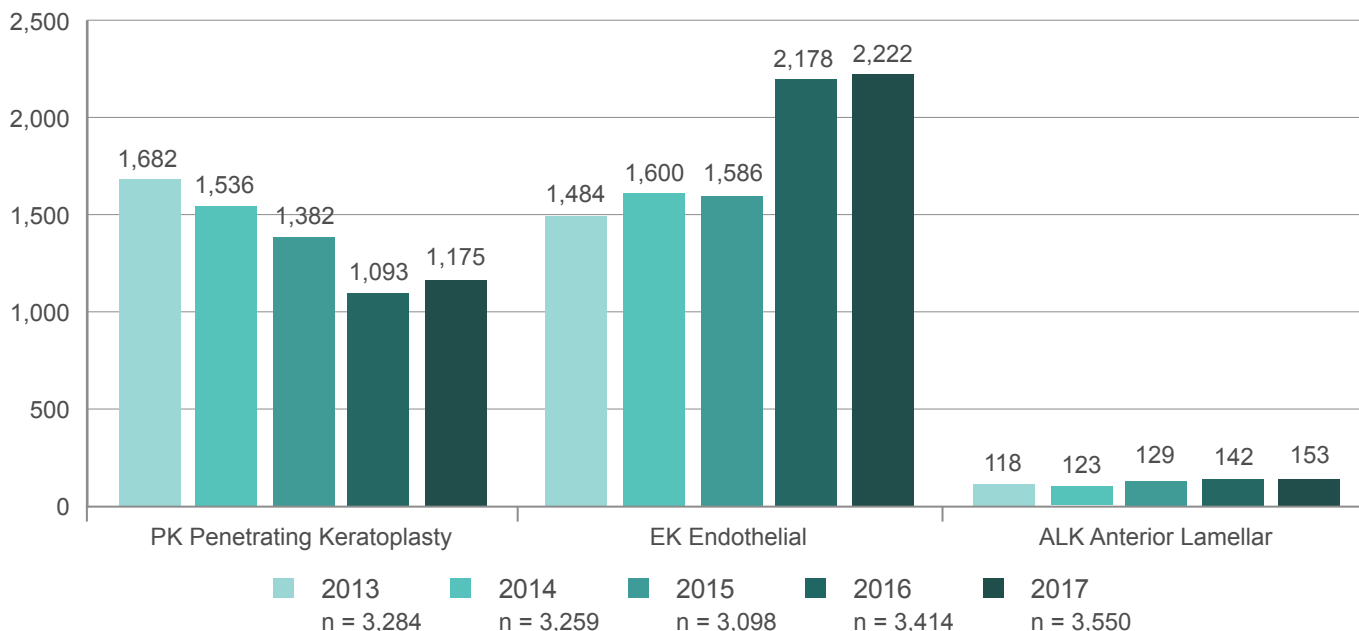
Not shown: five corneas distributed for keratoplasty other than PK, DMEK, DSAEK, or ALK in 2017 (including one case in which the cornea was distributed for an EK procedure other than DMEK/DSAEK); one cornea distributed for keratoplasty other than PK, EK, or ALK in 2016 and one equivalent case in 2015; 1 cornea distributed for EK for which specific procedure type could not be determined (2013); and long-term preserved corneas.

*Unknown cases reflect cornea distributions for which the keratoplasty type was not available, and may include non-keratoplasty procedures.

Of all cornea transplants performed in Canada in 2017 for which the keratoplasty type could be determined, 63% were endothelial keratoplasty (EK), which is on par with the proportion in 2016 (64%).

In 2017, five Canadian eye banks (Eye Bank of British Columbia, Eye Bank of Ontario, Héma-Québec's Banque d'yeux du Québec & Banque d'yeux du CUO, Nova Scotia's Regional Tissue Bank, and the Lions Eye Bank in AB) provided processing service, with all five providing precutting service for DSAEK. Two centres, the Regional Tissue Bank of Nova Scotia, and Québec's Banque d'yeux du Québec & Banque d'yeux du CUO provided pre-stripping service for DMEK. In remaining regions, the processing is completed by the surgeon in the operating room.

Cornea transplants by procedure type



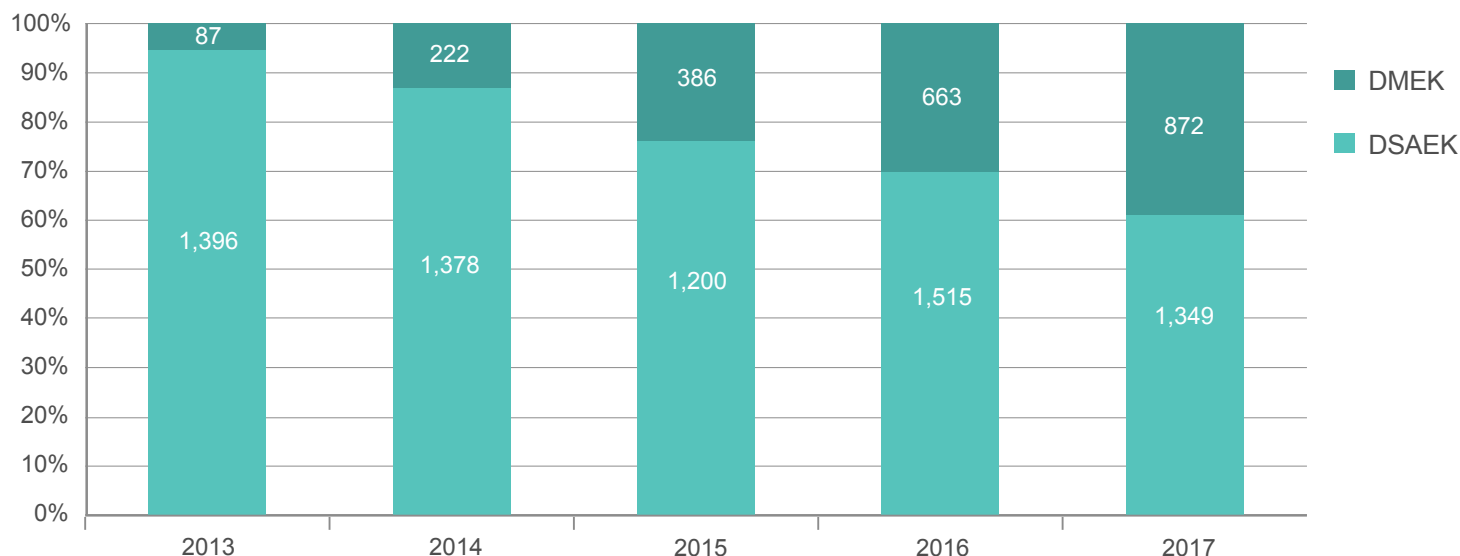
Long-term preserved corneas are not included in results presented. One intermediate-term preserved cornea was distributed for a keratoplasty procedure other than PK, EK, or ALK in 2015, as well as one in 2016 and four in 2017 (not shown). In 2017 220 intermediate-term corneas were distributed with the end use identified as "unknown" compared to 555 in 2016, 64 in 2015, 632 in 2014, and 220 in 2013. The high number of unknowns impacts the acuity of this data.

6.2 Type of endothelial keratoplasty

In endothelial keratoplasty either the eye bank prepares the corneal tissue prior to surgery, or the surgeon prepares the corneal tissue in the operating room, removing specific layers of the cornea. Preparation or pre-cutting can be done manually (peel) or with a microtome (automated). There are two common methodologies; in Descemet's Stripping (automated) Endothelial Keratoplasty (DSAEK), the prepared (cut) graft is comprised of the donor tissue endothelium, the Descemet's membrane, and a thin, partial layer of the donor tissue's stroma. Descemet's Membrane Endothelial Keratoplasty (DMEK) involves the transplantation of only the Descemet's membrane and endothelial layer of the cornea. The DMEK peel is a more technically challenging procedure than DSAEK and has been reported to provide better post-transplant patient visual acuity, lower rejection rates and faster visual recovery.

The demand for DMEK continues to increase, with a growth in DMEK procedures of 32% in 2017. In 2017, 39% of corneas known to have been used for EK procedures were used for DMEK.

Type of endothelial keratoplasty

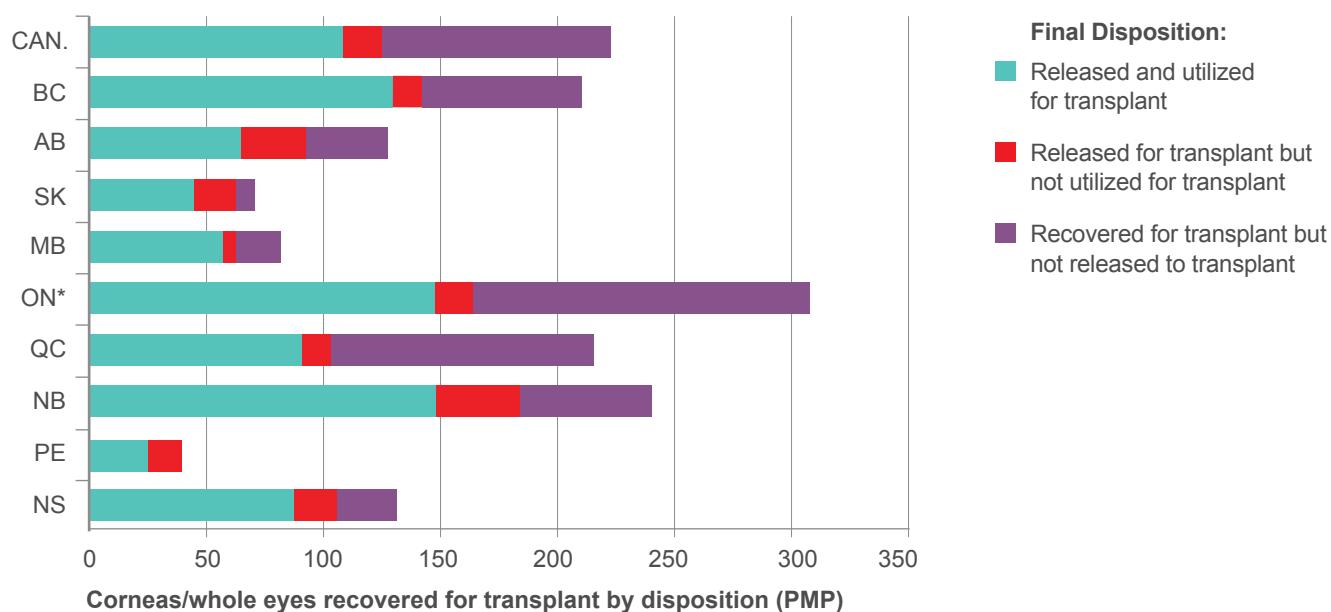


Not shown: two cornea distributed for EK for which specific procedure type could not be determined (2013, 2017). In 2017, 220 intermediate-term corneas were distributed with the end use identified as “unknown” compared to 555 in 2016, 64 in 2015, 632 in 2014, and 220 in 2013. The high number of unknowns impacts the acuity of this data.

6.3 Ocular tissue production and distribution: 2017 provincial analysis

Corneas/whole globes recovered with the intention for transplant

Results per million population (PMP)

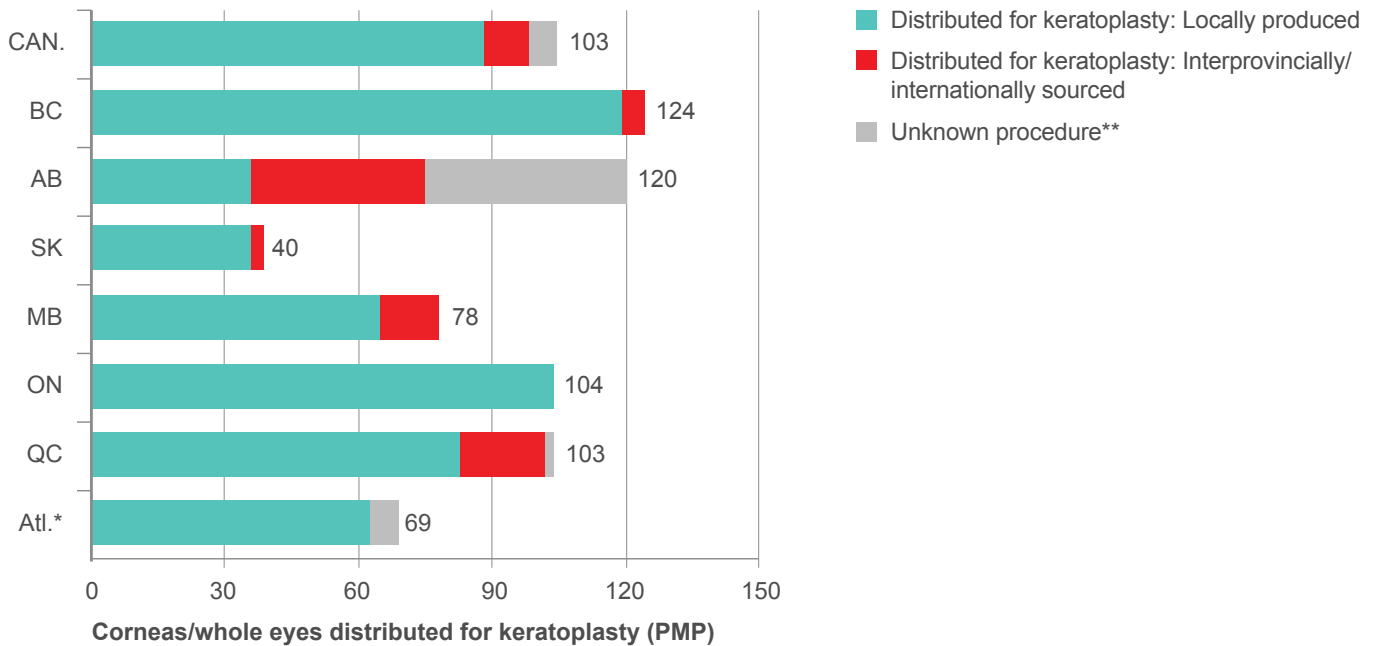


*Note: Ontario does not determine intention for transplant prior to recovery; Ontario results reflect all cornea/ globe recoveries.

NL donors were at one time processed by the NB program; however, as of the time of this report, NL donor recoveries were not being processed. As such, the NL population is not included in the NB recovery rate. PEI results reflect PEI donors whose recoveries were performed by the Nova Scotia program; New Brunswick donors whose recoveries were performed by the Nova Scotia program are included in New Brunswick results. Per million population rates based on Statistics Canada population estimates by province as of July 1, 2017 (Table 17-10-0086-01). National rate is based on the entire national population, including NL, YT, NT, and NU.

Total corneas distributed for keratoplasty

Results per million population (PMP)



* Atlantic patients are transplanted in Nova Scotia; rate calculation includes populations of all Atlantic provinces (NS, NB, PE, and NL).

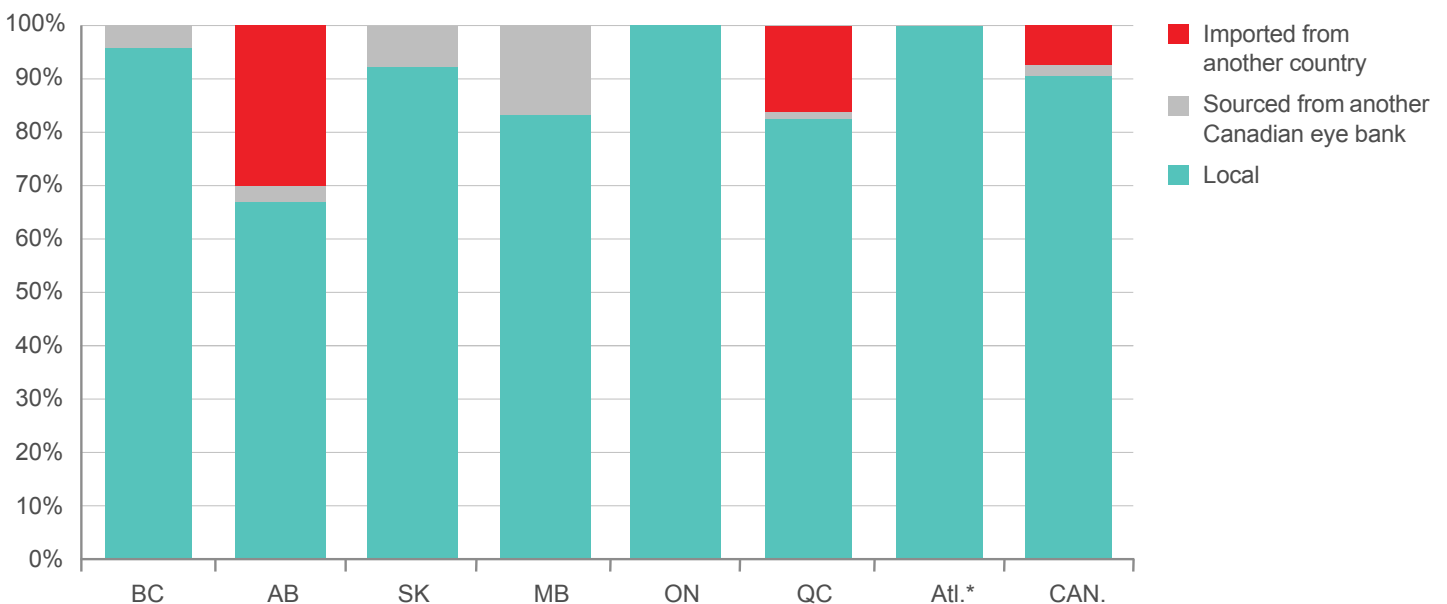
**Unknown cases reflect cornea distributions for which the procedure type was not available, and may include non-keratoplasty procedures.

Results presented do not include long-term preserved cornea distribution.

Per million population rates based on Statistics Canada population estimates by province as of July 1, 2017 (Table 17-10-0086-01).

National rate is based on the entire national population, including NL, YT, NT, and NU.

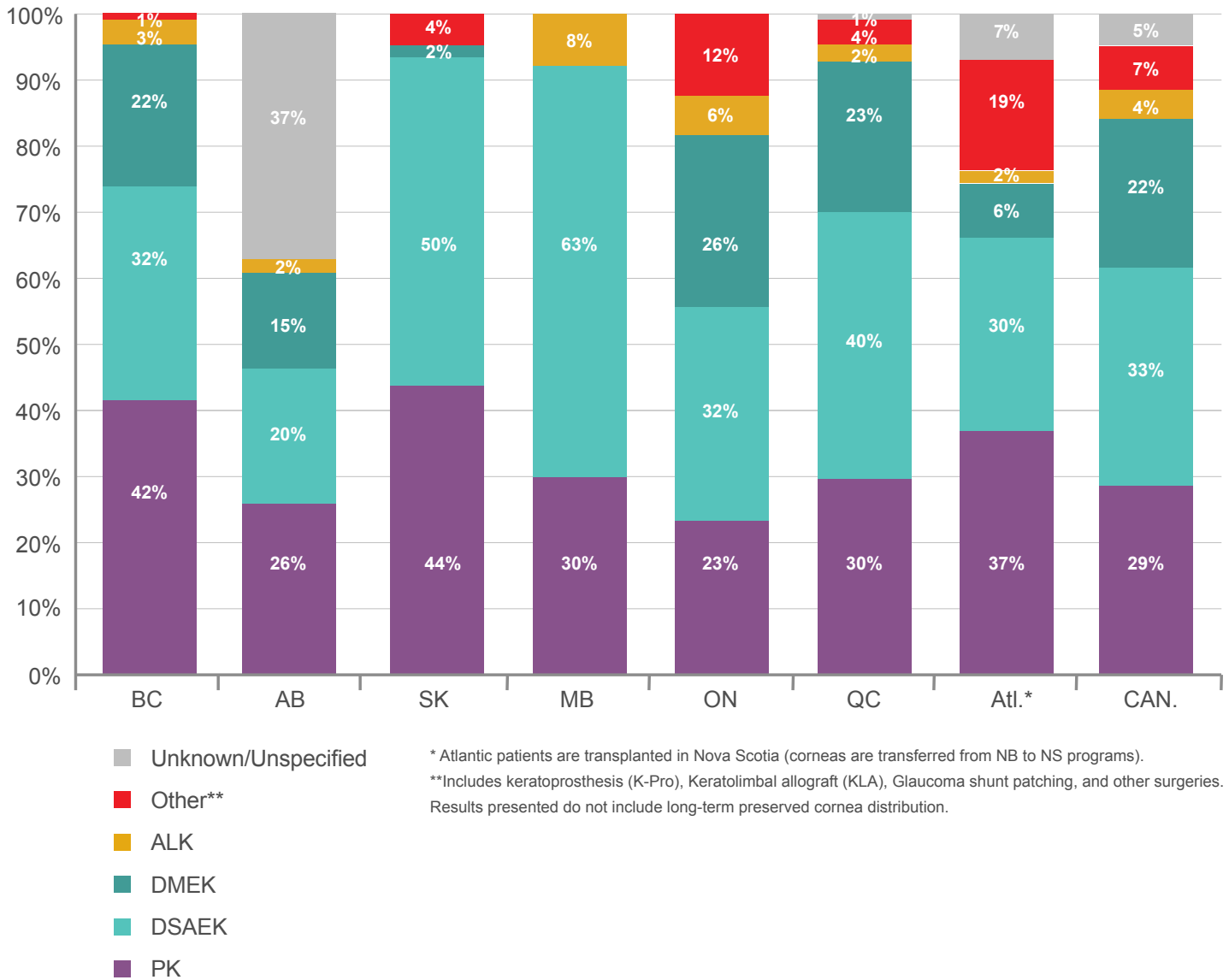
Source of corneas distributed for surgical use



* Atlantic patients are transplanted in Nova Scotia (corneas are transferred from NB to NS programs).

Corneas sourced from another Canadian eye bank in Alberta include corneas transferred between Alberta eye banks. Results presented do not include long-term preserved cornea distribution.

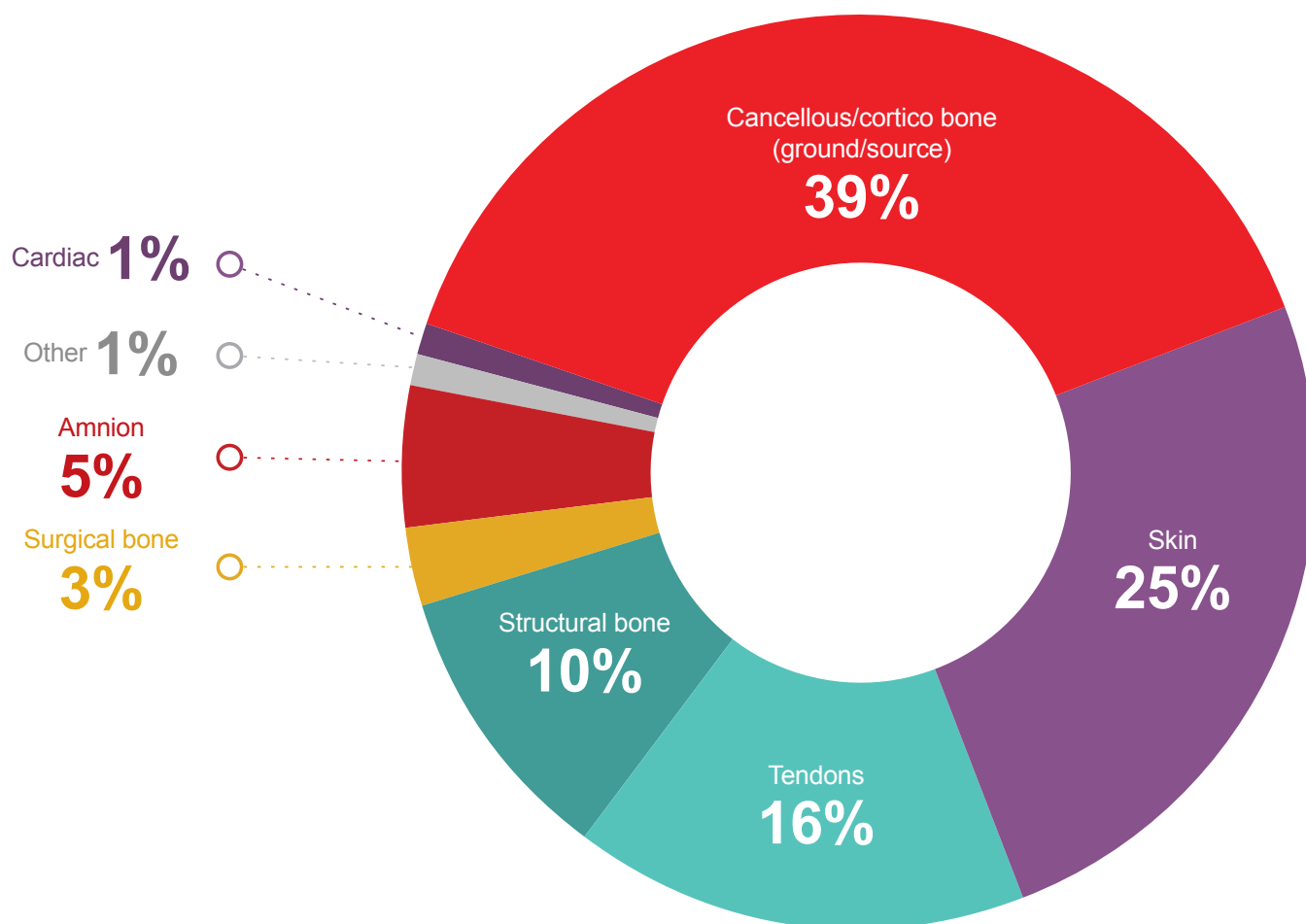
Corneas distributed for surgical use by type of surgery



6.4 Musculoskeletal, skin, cardiac and amnion tissue grafts processed and released to inventory

In 2017, ten tissue banks¹ processed and released 10,928 musculoskeletal, cardiac, skin, and amnion grafts from deceased and living donors into inventory for transplant.

Grafts processed & released to inventory, 2017

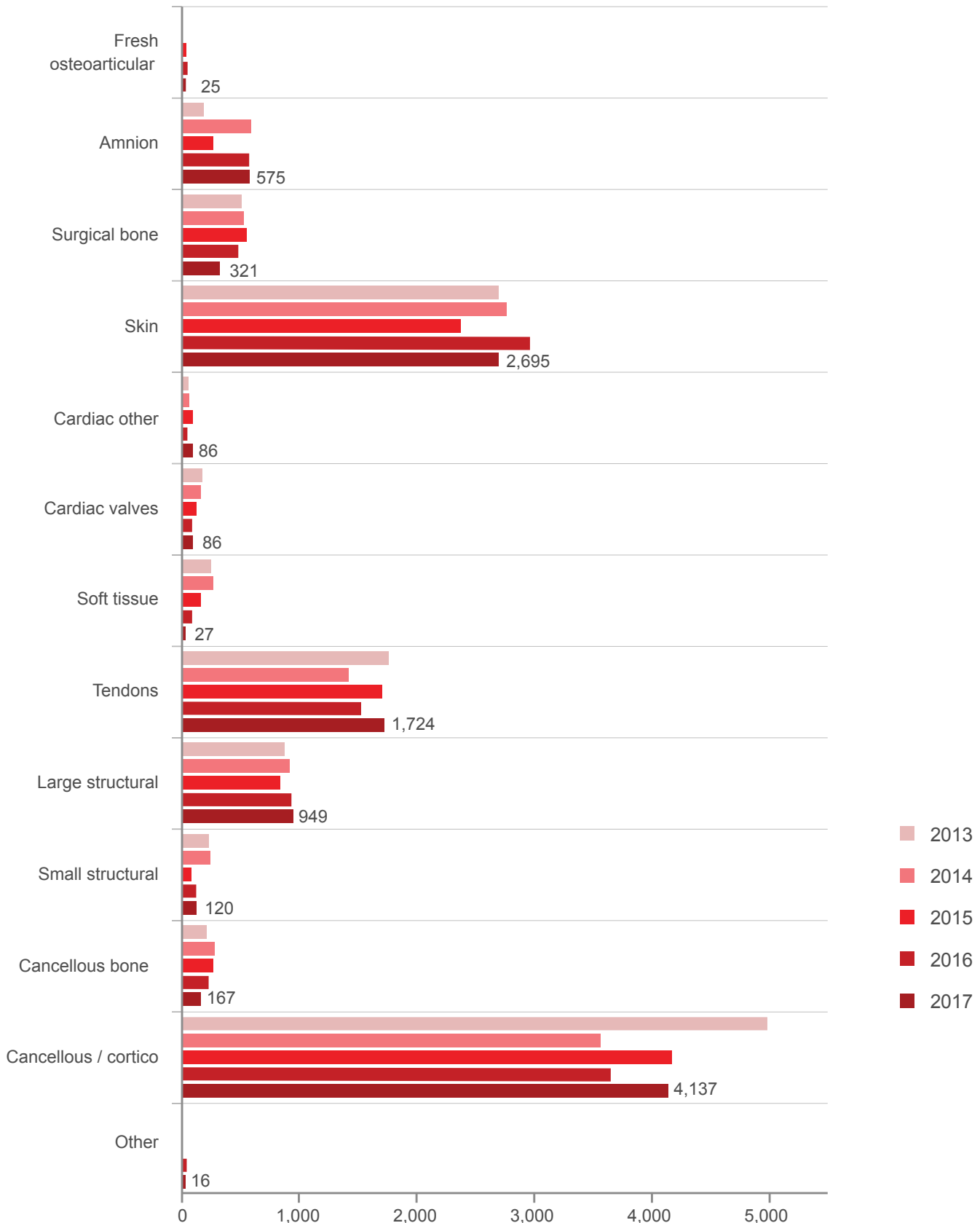


Total production has been essentially stable over the past four years, with each year being within two per cent of the four-year average (10,785). Production in 2013 was higher at 12,045 grafts produced.

2017 results suggest that cancellous/cortico bone production has returned to 2015 levels after dropping 13% (n=557) in 2016 relative to 2015. Similarly, despite a 10% decrease in tendon production (n=177) between 2015 and 2016, the 1,724 tendon grafts produced in 2017 is also on par with the 1,707 grafts produced in 2015. Structural bone graft production increased by two per cent in 2017 relative to 2016 overall (n=23); however, skin graft production decreased nine per cent in 2017 (n=268). Amnion production remained stable in 2017, while surgical bone production continued to decrease in proportion with the decrease in living donor recoveries. Although 172 cardiac were grafts produced in 2017, representing a 19% increase from 2016 (n=28), current production is still well below 2015 and earlier levels.

¹There are four banks in Ontario producing musculoskeletal, skin, cardiac, and/or amnion tissue; those banks submit program data to the Trillium Gift of Life Network.

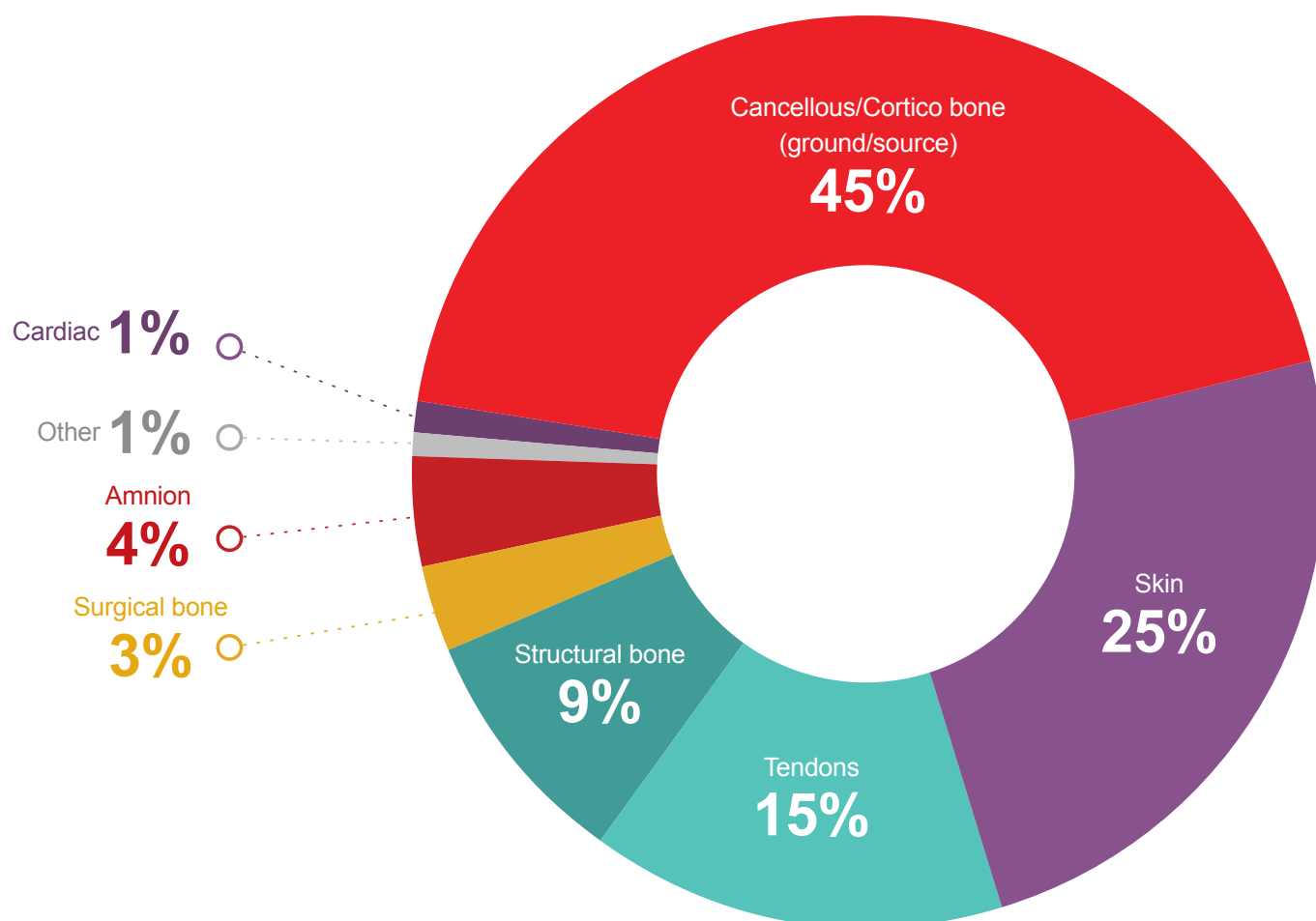
Number of grafts processed & released to inventory



6.5 Musculoskeletal, skin, cardiac and amnion tissue grafts distributed to transplant

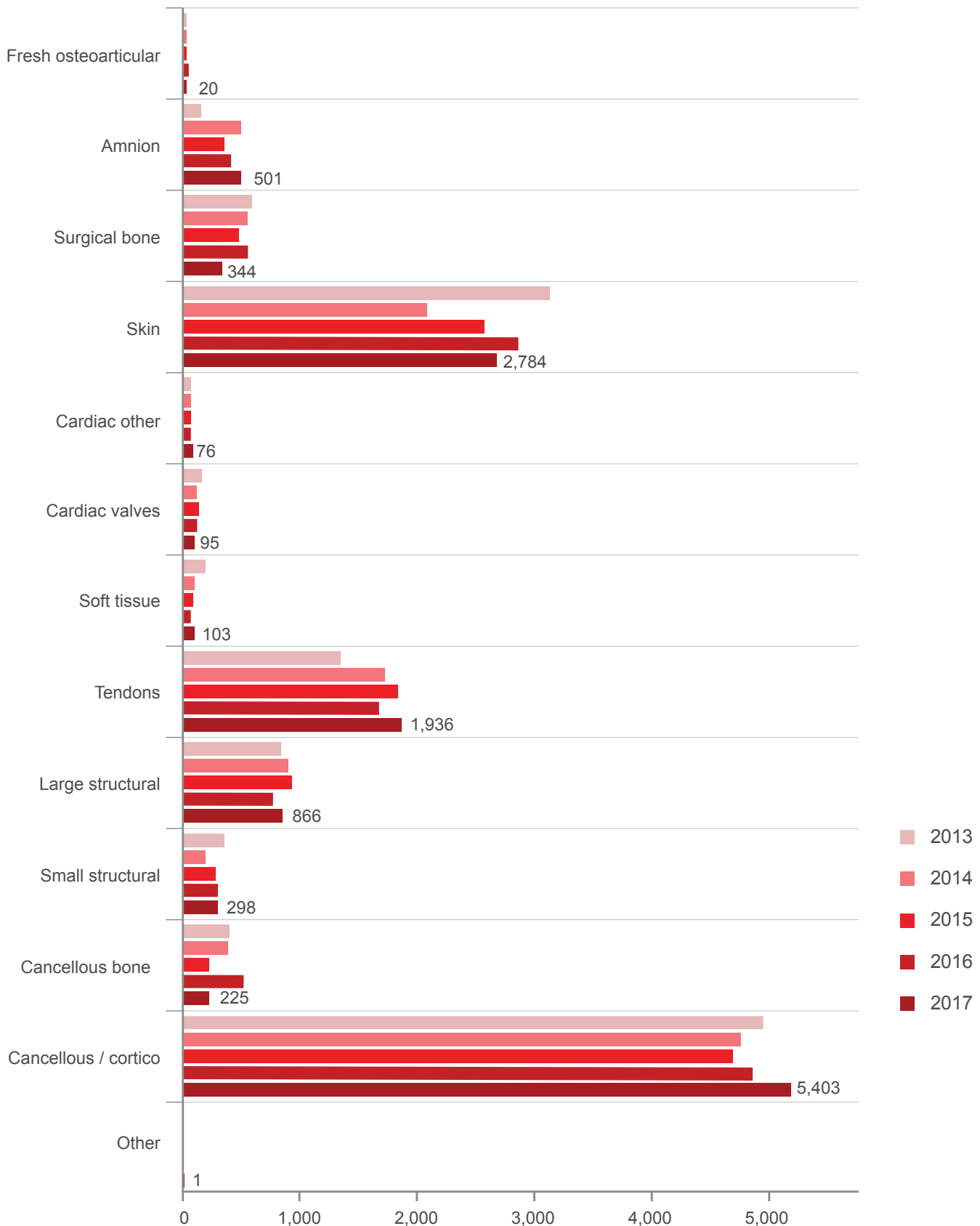
In 2017, eleven tissue banks distributed 12,652 musculoskeletal, skin, cardiac and amnion grafts to transplantation, reflecting almost no change from the 12,632 grafts distributed in 2016. Total distribution in 2016 and 2017 was essentially equivalent to the total in 2013 (n=12,605). While ten banks produce allografts, an eleventh has a relationship with American processors who produce allografts from donors recovered by that bank and return them for distribution.

Grafts distributed to transplant, 2017



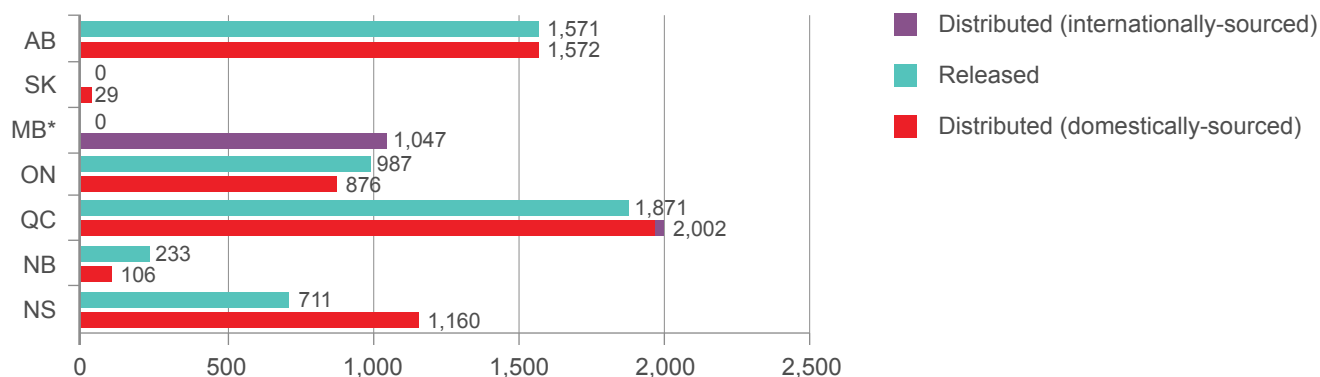
Fresh osteoarticular and cancellous bone distribution reached a four-year high in 2016, but seem to have returned to 2015 levels. In 2017, the number of cardiac valve grafts distributed continued to decline, while non-valve cardiac graft distribution increased in 2017 resulting in a net stability in cardiac graft distribution overall. The greatest proportional increase among tissue types was in soft tissue, which nearly doubled in distribution in 2017 relative to the previous year, returning to 2014 levels. Distribution for cancellous/cortico bone, structural bone, tendon, and skin grafts were within 12% of 2016 distribution, with cancellous/cortico and tendon graft distribution reaching new highs in 2017.

Number of grafts distributed to transplant

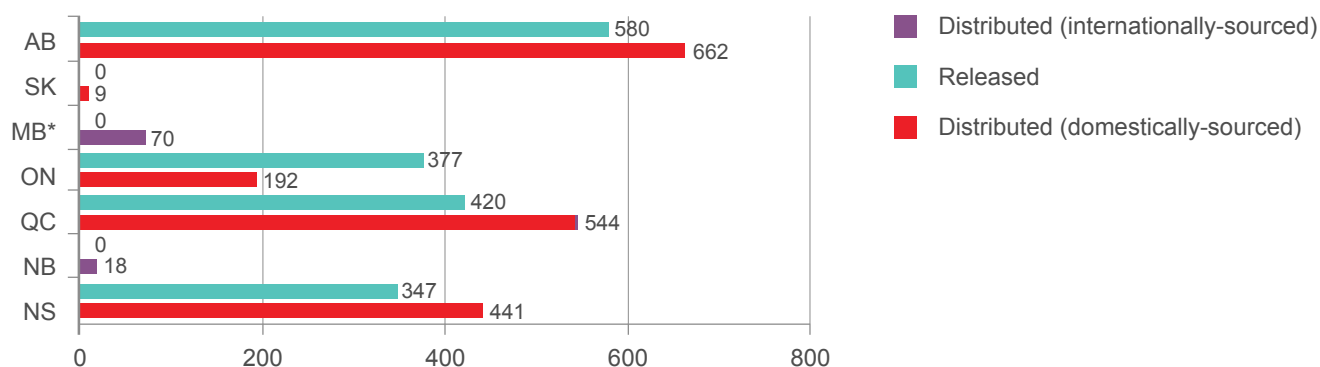


6.6 Deceased donor musculoskeletal, skin, and cardiac tissue: 2017 provincial analysis

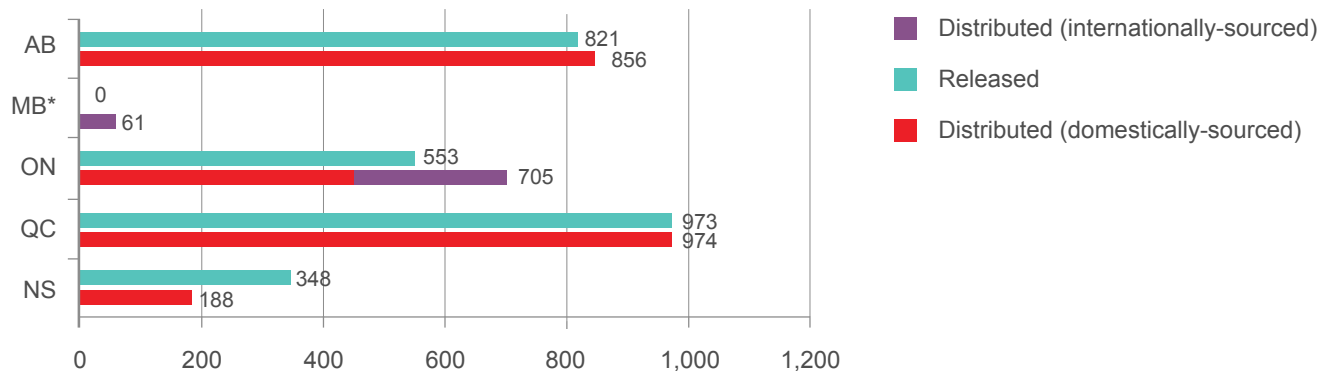
Musculoskeletal grafts released/distributed for transplant



Tendon grafts released/distributed for transplant

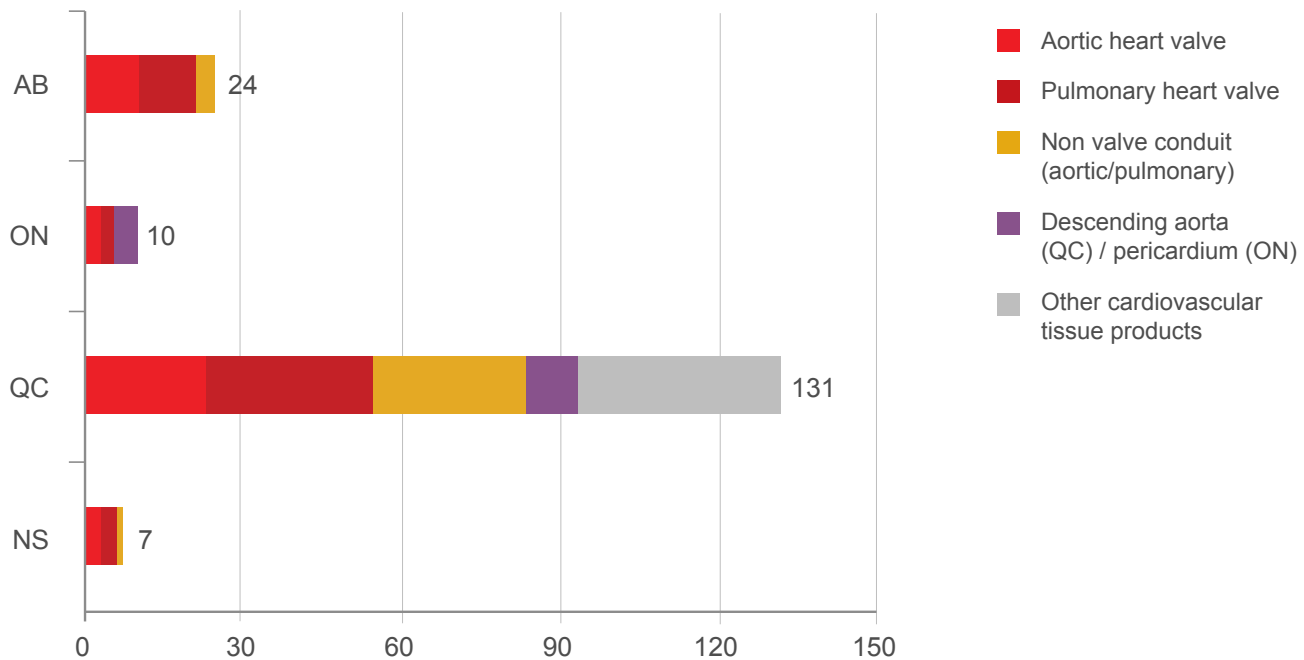


Skin grafts released/distributed for transplant

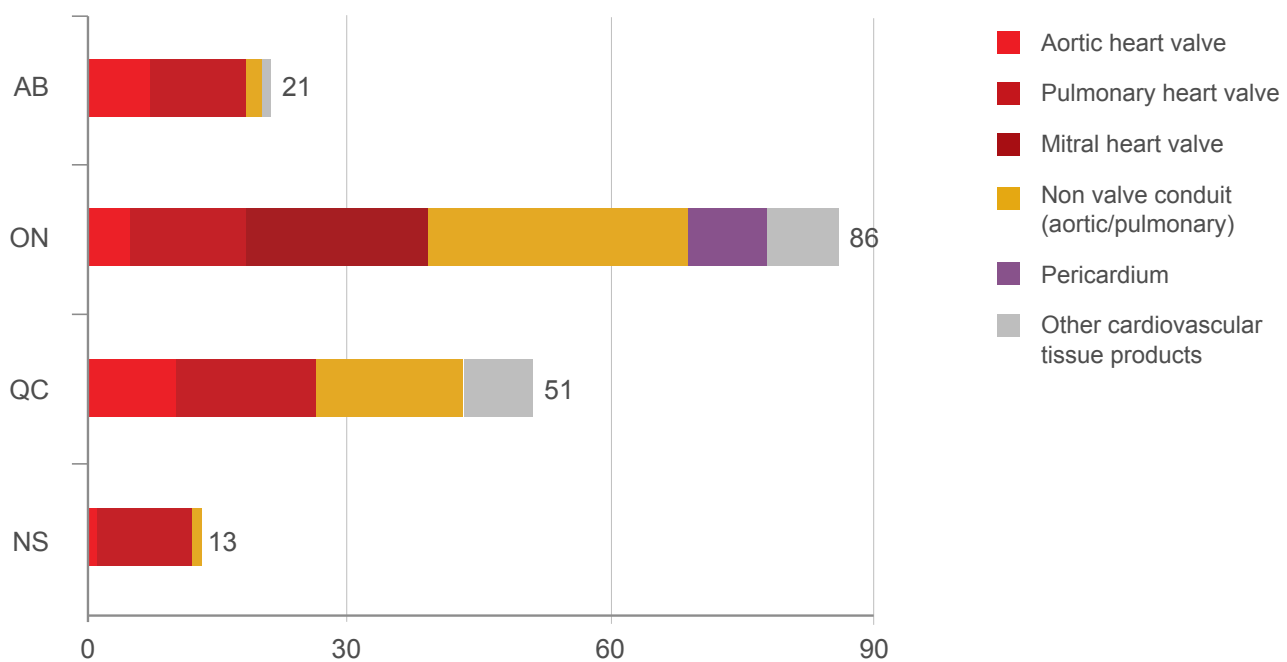


* Tissue Bank Manitoba is a recovery organization that sends tissues to a US partner organization for processing and receives a proportional quantity of tissue grafts in return for distribution in their province.

Cardiac grafts processed and released for transplant



Cardiac grafts distributed for transplant



With the support of eye and tissue banks in Canada, and in collaboration with Canadian Blood Services, this census of Canadian tissue recovery, allograft production, and distribution activity provides data to inform on the operational strategy of individual banks as well as providing insight and trend analysis to inform national policy development. A data committee consisting of representation from the majority of Canadian eye and tissue banks continues to evolve minimal data sets, data definitions, data processes, and quality assurance, and undertakes analysis to identify trends in activities to inform strategy.

Five years of sequential data analysis provides insight into national trends and will inform individual tissue bank operations and strategy. Recent insights identified for consideration in operational planning and policy development include:

- **Canadian production and distribution of musculoskeletal, skin, cardiac and amnion grafts overall is stable, with no significant variance in activity over the past five years.**

Canadian demographics indicate an aging population; as such, we would expect to see an increasing demand for musculoskeletal grafts; however, results indicate no significant growth in Canadian musculoskeletal allograft production or distribution over the last five years. We also know from previous market analysis there is a significant demand and competitive market for advanced musculoskeletal products, such as demineralized bone products, and that Canadian hospitals meet their requirements for these products solely by importing from the US since there are no Canadian banks producing advanced bone grafts.

The lack of growth in Canadian production and distribution of basic allografts, in an environment of increasing demand, could indicate that hospitals are importing more allografts from the US to meet both their basic and advanced allograft needs.

- **Canadian production and distribution of corneas for transplantation is stable, with no significant variance in activity over the past five years.**

Despite overall stability in total production and distribution, the demand for endothelial keratoplasty (cornea transplant) continues to increase. Within endothelial keratoplasty, the demand for DMEK procedures continues to grow, with 39% of all endothelial keratoplasty's requiring DMEK processing in 2017.

The improved outcomes with endothelial keratoplasty support increasing demand for this corneal processing, necessitating the investment of training and capital to support this advanced processing activity. The rate of endothelial keratoplasty in Canada is equivalent to the United States practice. The rapid increase in demand for DMEK processing, a highly technical procedure required advanced process skills, continues.

Programs should consider this growth trend when planning for ocular processing capacity.

- **Canadian production and distribution of surgical bone grafts continues to decline.**

With increasing regulatory requirements many Canadian centres discontinued surgical bone banking as the costs of regulatory compliance exceeded the costs of allograft purchase. As such, the decline in surgical bone banking continues.

- **There is significant variance in the corneal transplantation rate between provinces.**

Rates range from 40 to 124 corneas distributed for transplant per million population between provinces. 2017 cornea distribution results are generally consistent with 2016 for most provinces. Many factors may contribute to corneal transplantation rate; these would include availability of donated corneas, number of transplanting ophthalmologists, availability of operating room time, procedure funding, and patient demographics. Data indicates significant variation in corneal transplant rate between provinces; jurisdictions should be considerate of this variance.

Data indicates a continued dependence on the United States for corneas to supplement Canadian production, with approximately eight per cent of all cornea transplants performed in Canada utilizing corneas imported from the United States.

The ETDC does not have sufficient data to support causation analysis of variance in provincial corneal transplantation rate. The variance of transplantation rate requires consideration as it may be an indicator of inequitable access to ocular care between jurisdictions.

The prospective collection and collation of national eye and tissue bank activity provides insight into the Canadian supply and demand. As data accumulates, more sophisticated trend analysis will help inform recovery and production targets and methodologies. Strategies to better align supply with demand nationwide can be developed using the collected data as a guide. The data collected also has the potential to inform further research in the ocular and tissue transplantation world, as a significant starting point for most research requires a broad tablet of basic data. Similarly, interprovincial comparisons offer insight into areas of potential resource and knowledge sharing, while providing a more nuanced understanding of provincial demand and reliance on internationally-sourced grafts.

Appendix A:

terms, definitions, and abbreviations

Amniotic membrane

The innermost layer of the placenta consisting of a thick basement membrane and an avascular stromal matrix. It is used as a graft and as a dressing to facilitate ocular surface reconstruction and to promote healing. Its use in plastic surgery (burns, wound care), orthopedic, dental and general surgery is increasing.

Deep anterior lamellar keratoplasty (DALK or ALK)

A partial thickness corneal transplant procedure used to treat disease or injury confined to anterior layers of the cornea: the epithelium, Bowman's layer and stroma. DALK is most often used to treat keratoconus and corneal scarring.

Cancellous / cortical bone

There are two types of osseous tissue that form bones; cancellous "spongy" bone and cortical "compact" bone. Tissue banks mill/grind bone into cancellous cortical particles or powder which is used to pack bone voids in surgical repairs.

Chipped bone

Bone that has been processed into morsels; chipped bone is used to pack bone voids in surgical repairs.

Consent (rate)

Consent refers to signed documentation of approval to proceed with donation from the donor or legal next of kin; the consent rate is the ratio of donors where consent for donation is obtained to the number of donor families approached for consent.

Deceased donor

A donor from whom tissue is recovered following cardiocirculatory or neurological determination of death.

Descemet's membrane endothelial keratoplasty (DMEK)

DMEK involves the transplantation of only the Descemet's membrane and endothelial layer of the cornea. The preparation (processing) of the cornea is done manually. DMEK has been described as a more technically challenging surgical procedure than DSAEK but also has been reported to provide better, post-transplant patient visual acuity, lower rejection rates and faster visual recovery.

Descemet's stripping (automated) endothelial keratoplasty (DSAEK)

A partial-thickness cornea transplant involving the transplantation of donor tissue endothelium, Descemet's membrane and a thin, partial layer of the donor tissue's stroma. The preparation (processing) of the cornea is automated utilizing a microtome.

Distribution

A process that includes the receipt of a request for tissue, selection and inspection of the appropriate tissue and subsequent shipment and delivery of the tissue to the end user (surgeon) for utilization.

Endothelial keratoplasty (EK)

A corneal transplant procedure where only a patient's compromised posterior layers of the cornea are removed and replaced by similar posterior corneal layers of a donor cornea. The advent of this procedure occurred in the early to mid-2000s after fifty years of performing penetrating keratoplasty in nearly all corneal transplant surgeries. EK has clearly established itself as the standard of care for patients with endothelial dysfunction. There are a number of types of EK procedures including DSAEK and DMEK. They can be performed manually (peel) or automated (microtome).

Eye and Tissue Data Committee (ETDC)

A Canadian committee chaired by members of the tissue community and composed of representatives from each provincial tissue program as well as Canadian Blood Services representatives with the purpose to oversee the collection, management and release of national eye and tissue allograft data.

Fresh osteoarticular

Osteoarticular refers to a bone graft that contains a joint surface; such as a knee. Fresh refers to the fact that, in order to preserve viability of joint tissue, the graft is not frozen or cryopreserved. These grafts are refrigerated and usually transplanted within weeks of recovery.

Keratoplasty

A surgical procedure, also known as corneal transplantation, where the procedure involves a replacement of abnormal host tissue with healthy corneal tissue from a donor. The replacement of the corneal tissue can either be partial or full depending on the severity of damage in the cornea.

Living donor

A donor where tissue is recovered from a live person; such as femoral heads which are recovered during total hip replacements or amnion which is recovered from the placenta in live births.

Ocular

A general term which refers to the tissues of the eye which include the cornea and the sclera.

Penetrating keratoplasty (PK)

Corneal transplant with replacement of all layers of the cornea but retaining the peripheral cornea.

Per million population (PMP)

To provide comparative data donation ratios such as the number of donors per million population - may be presented. For reports generated by the Eye and Tissue Data Committee the numerator - # of donors - refers to the province where the donor was identified and recovered as opposed to the province of the recovery organization.

Preservation, intermediate-term

Cornea or corneal section preserved in a solution that maintains cellular and/or ultrastructure viability for 14 days. Intermediate term preservation is currently utilized at 2-8°C storage temperatures. Examples of intermediate term storage media are: Life4°C, Optisol GS, and Eusol.

Preservation, long-term

Cornea or corneal section stored in a solution that is designed to maintain tissue ultrastructure for greater than 14 days and up to five years depending on the technique. Viability is not maintained. Examples are ethanol and glycerin preservation. Other media, such as albumin, may be used in conjunction with ionizing radiation to preserve the tissue ultrastructure.

Processing

The steps taken following recovery to prepare tissue for transplantation. This is essentially a manufacturing process where tissue is manipulated, treated and packaged into forms required by surgeons for interventions and through which quality control and quality assurance processes determine safety and the product release to transplantation. Packaging is considered a type of processing.

Recovery

Obtaining tissue from a donor that is intended for use in human transplantation, therapy, research or education. The surgical removal of donated tissue for future processing; recovery generally occurs in an operating room or dedicated recovery suite.

Referral

A referral is when a death is referred to a donation organization or tissue bank for consideration or evaluation of donation potential. In some jurisdictions all deaths are referred and in others frontline health professionals may do a pre-screening and only refer deaths which have no obvious contraindications to donation.

Released to inventory

Refers to grafts that has been evaluated, and deemed safe and suitable for transplantation, by a medical director, through the appropriate quality review and made available for transplantation. Prior to release grafts in the production process are considered quarantined.

Sclera

The sclera is the part of the eye commonly known as the “white”. It forms the supporting wall of the eyeball, and is continuous with the clear cornea. Scleral grafts are widely used in ophthalmologic surgery.

Soft tissue

A generic term for muscle, fat, fibrous tissue or other supporting tissue matrix. In tissue banking it often refers to fascia lata; the sheets of fibrous tissue enveloping, separating or binding together muscles and organs. Fascia lata is processed into grafts for use in surgical repairs.

Structural bone

Structural I bone grafts are intended to support weight and are classified into large or small. Large grafts include femurs, fibulas and humerus. Small grafts include sized grafts such as cortical dowels, wedges and rings.

Surgical bone

Femoral heads can be recovered from total hip replacements and evaluated for suitability to transplant. These femoral heads are referred to as surgical bone. Surgeons grind the femoral head in the operating room to produce cancellous powder or particles. With the advent of bank produced pre-packaged cancellous and the increasing regulatory requirements the demand for surgical bone has declined.

Tendon

A band of tough, inelastic fibrous tissue that connects a muscle with its boney attachment. Tendons commonly banked for use in sports medicine surgery include Achilles, Patellar and Tibialis.

Yield

Yield refers to the number of grafts which are recovered and released (deemed suitable) for transplant per donor. Yield can be affected by contamination, recovery technique, processing technique and donor factors such as age and comorbid diseases.

Appendix B: Eye and Tissue Data Committee membership

Member	Title	Program
Alison Halliday	Senior Technologist	Ontario Professional Firefighters' Skin Bank, Toronto, ON
Balram Sukhu	Director	Mount Sinai Allograft Technologies, Toronto, ON
Brenda Weiss	Patient Care Manager Ophthalmology Clinic	Misericordia Health Centre, Winnipeg, MB
Christine Humphreys	Director	Eye Bank of Canada (Ontario Division), Toronto, ON
Cynthia Johnston (Chair)	Quality Leader	Regional Tissue Bank, Halifax, NS
Debbie Jefferson	Interim Director	New Brunswick Organ and Tissue Program, Saint John and Moncton, NB
Ellen Sokol	Deceased Donation Coordinator	Saskatchewan Transplant Program, Saskatoon, SK
Gary Rockl	Tissue Innovation Specialist	Héma-Québec, Québec City, QC
Ivan Yan	Head Technologist	Eye Bank of British Columbia, Vancouver, BC
Kimberly Dodds	Director	Tissue Bank Manitoba
Mijana Ridic	Unit Manager, Lions Eye Bank	Southern Alberta Organ and Tissue Program, Calgary, AB
Mike Bentley	Manager, Transplant Services	Comprehensive Tissue Centre, Edmonton, AB
Natalie Smigielski	Manager - PRC - Tissue Program	Trillium Gift of Life Network, Toronto, ON
Ryan Funk	Senior Tissue Specialist	Southern Alberta Tissue Program

Canadian Blood Services Members

Jim Mohr

A/Associate Director, Deceased Donation

Kyle Maru

Sr. Data Analyst, Information Management

Appendix C: list of contributing programs

British Columbia

- Eye Bank of British Columbia, Vancouver
- Island Health Bone Bank, Victoria

Alberta

- Southern Alberta Tissue Program, Calgary
- Lions Eye Bank of Calgary, Calgary
- Comprehensive Tissue Centre, Edmonton

Saskatchewan

- Saskatchewan Transplant Program, Saskatoon

Manitoba

- Tissue Bank Manitoba, Winnipeg
- Misericordia Eye Bank, Winnipeg

Ontario

Trillium Gift of Life Network manages the collation and submission of data from Ontario eye and tissue banks including:

- Eye Bank of Canada (Ontario Division), Toronto, Ontario
- The Hospital for Sick Children Tissue Laboratory, Toronto, Ontario
- Ontario Professional Fire Fighters Skin Bank, Toronto, Ontario
- Mount Sinai Allograft Technologies, Toronto, Ontario
- Lake Superior Centre for Regenerative Medicine, Thunder Bay, Ontario

Trillium Gift of Life Network supports tissue recovery and therefore qualifies as a recovery organization.

Québec

- Héma-Québec, Saint Laurent: Banque d'yeux du Québec & Banque d'yeux du CUO

New Brunswick

- New Brunswick Organ and Tissue Program; Ocular and Tissue Division, Saint John and Moncton

Nova Scotia

- Regional Tissue Bank, Halifax

Appendix D: list of products programs produce*

Canadian eye banks	PK corneas	DSAEK corneas	DMEK corneas	Sclera	Amnion
Eye Bank of British Columbia	Y	Y	N	Y	N
Lions Eye Bank of Calgary	Y	Y	N	Y	N
Comprehensive Tissue Centre (AB)	Y	N	N	Y	Y
Saskatchewan Transplant	Y	N	N	Y	N
Misericordia Eye Bank	Y	N	N	Y	Y
Eye Bank of Ontario	Y	Y	N	Y	Y
Héma-Québec	Y	Y	Y	Y	N
New Brunswick Organ and Tissue Program	Y	N	N	Y	N
Regional Tissue Bank (NS)	Y	Y	Y	Y	N

*as of publication

Appendix D continued

Canadian tissue banks	Cancellous bone	Structural bone	Rib or cartilage	Tendon	Fresh osteo	Soft tissue	Cardiac	Skin
Island Health Bone Bank (BC) (Surgical Bone)	Y	N	N	N	N	N	N	N
Southern Alberta Tissue Program	Y	Y	Y	Y	Y	Y	N	Y
Comprehensive Tissue Centre (AB)	Y	Y	Y	Y	N	Y	Y	Y
Saskatchewan Transplant	Y	Y	N	Y	N	N	N	N
Tissue Bank Manitoba*	Y	Y	Y	Y	N	Y	Y	Y
RegenMed (ON)	Y	Y	N	Y	N	N	N	N
Mount Sinai Allograft Technologies (ON)	Y	Y	N	Y	Y	N	N	N
Hospital for Sick Children, Tissue (ON)	N	N	N	N	N	N	Y	N
Ontario Professional Firefighters Skin Bank	N	N	N	N	N	N	N	Y
Héma-Québec	Y	Y	N	Y	N	N	Y	Y
New Brunswick Organ and Tissue	Y	Y	N	Y	N	N	N	N
Regional Tissue Bank (NS)	Y	Y	N	Y	Y	Y	Y	Y

* Relationship with US programs who process MB donors and return tissue for distribution