Research for the Health of the Population of Québec

2021–2022 Scientific Activities Report

HÉMA-QUÉBEC

SUMMARY

Scientific activities are labelled with the below icons, which indicate the type of product to which they pertain.


BLOOD PRODUCTS


STABLE PRODUCTS


STEM CELLS


HUMAN TISSUES


MOTHER'S MILK

Scientific activities related to this year's highlights, that is COVID-19 and the inclusivity of blood donation, are labelled with the below icons.


COVID-19


Inclusivity of blood donation

This report is published by the Vice-présidence aux affaires médicales et à l'innovation in collaboration with the Direction stratégique des communications intégrées, with a contribution to the content provided by the Vice-présidence à la médecine transfusionnelle.

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Original text in French. In the event of a discrepancy between the English and French versions, the latter will prevail.

“These rich and diversified results are a testament to the vitality of our teams, and underscore the vital role played by research and development at Héma-Québec and in Québec society.”

Dear Reader,

It is a great pleasure for me to present Héma-Québec’s Scientific Activities Report, which covers the period from April 1, 2021, to December 31, 2022. The projects described in these pages were accomplished by teams from the Vice-présidence à la médecine transfusionnelle (MT), under the direction of Dr. Nancy Robitaille, and the Vice-présidence aux affaires médicales et à l’innovation (AMI), under my direction.

While our activities were progressively redirected toward research projects that focus on our central mission, COVID-19 again monopolized our activities in no small measure. Héma-Québec contributed to advancing knowledge about SARS-CoV-2 and COVID-19, especially by establishing the PlasCoV plasma donor biobank. This resource garnered the interest of several research teams in Québec that conducted population studies on the immune response to SARS-CoV-2 following infection or vaccination. PlasCoV falls within Héma-Québec’s desire to be a first-line partner to the health system and to contribute to public health initiatives.

A rapid test was also developed, as part of an international multicentre study, to assess the hematopoietic reconstitution potential of cord blood donations. The results of this study, which were the fruit of a collaboration between the vice-presidencies AMI and MT, confirmed the predictive value of this test. The eventual adoption of the test by cord blood banks around the world could have significant benefits for stem cell transplantation, especially by accelerating the selection of cord blood units and stem cell transplants.

On another note, epidemiological studies conducted in collaboration with the Canadian Blood Services made it possible to expand blood donation eligibility without affecting the safety of recipients. Thanks to an individualized evaluation of risk practices and behaviours (without reference to the donor’s sex, gender or sexual orientation), men who have had sex with other men in the last three months can now donate plasma for fractionation (since October 2, 2022) and blood (since December 4, 2022). In addition, Héma-Québec plans to submit a request to enable persons who travelled to Western Europe to give blood, without increasing the risk of transmission of variant Creutzfeldt-Jakob disease.

A major part of Héma-Québec’s research and development efforts is devoted to supporting our operations. Temperature and climate variations in Quebec present a particular challenge. Summer and winter, the vast majority of whole blood donations must be refrigerated, at the same temperature, during transport from remote collection sites to our preparation centres in Montréal and Québec. The same holds true for blood components delivered to hospitals. Several projects were completed in 2021-2022 to validate, optimize and improve the systems used to maintain the temperature of blood products during transportation. These projects will make it possible to limit the number of expired products, thus improving their quality and consistency.

Other projects were carried out by the Human Tissues division. This research, which focuses on improving tissue processing methods, is part of Héma-Québec’s objective of improving quality and efficiency. Significant progress has been made in this area: in August 2021, the ministère de la Sante et des Services sociaux entrusted our organization with the mandate of sole distributor of human tissues in the hospital network, which will be effective in fall 2024.

These rich and diversified results are a testament to the vitality of the vice-presidencies AMI and MT and underscore the vital role played by research and development at Héma-Québec and in Québec society.

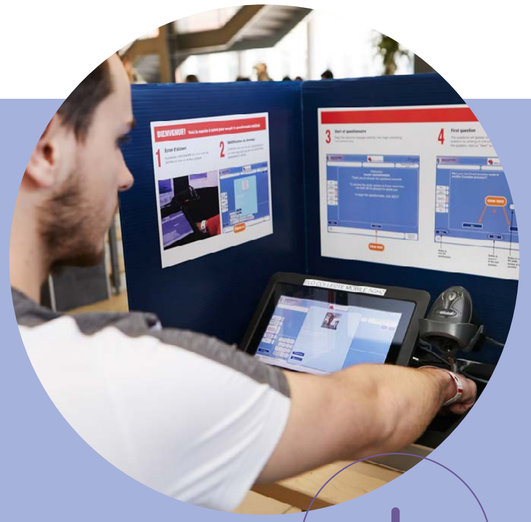
Good reading!

Marc Germain, MD, FRCP(C), PhD
Vice President, Medical Affairs and Innovation

HIGHLIGHTS

The study of the seroprevalence of antibodies directed against SARS-CoV-2 continued
with the help of a new test targeting anti-nucleocapsid and a more sensitive analytical method.

A test designed to assess the regenerative potential of stem cells (IL-3-pSTAT5) has shown an excellent performance
in an international multicentre study.



The pre-donation questionnaire was revised and is now based on an individualized evaluation
of donors' at-risk behaviours, rather than an evaluation of specific groups. Henceforth, anyone who wants to donate blood, platelets, or plasma must fill the same questionnaire, regardless of their sex, gender, or sexual orientation. This change enables a more inclusive approach to people hailing from LGBTQ+ communities.

Lymphopenia, which affects many frequent platelet donors,
does not compromise their humoral immune response to vaccines for COVID-19.

The PlasCoV biobank, established to facilitate research
on immunity to COVID-19, contained **151,000** donations from **21,000** plasma donors (as of October 2022).

A new test was developed
to identify IgA-deficient donors.

Héma-Québec contributed to two randomized, placebo-controlled studies
to assess the effect of convalescent plasma in patients hospitalized for COVID-19 (CONCOR-1 Study) and seriously ill patients with COVID-19 (REMAP-CAP Study). The two studies were published in *JAMA* and *Nature Medicine*.

Partner of the health system

A biobank of plasma donors to better understand immunity to COVID-19 (PlasCoV)

Despite remarkable progress, our understanding of the humoral immunity to COVID-19 remains incomplete. Historically, biobanks have significantly contributed to advancing research into rare or emerging diseases, but existing biobanks are not optimal for conducting longitudinal studies of immunity to COVID-19.

In collaboration with the Public Health Agency of Canada (PHAC) and the COVID-19 Immunity Task Force (CITF), Héma-Québec has established a biobank of plasma donations to better understand immunity to COVID-19. As of October 2022, the biobank contained 151,376 plasma samples from 20,559 donors. Nearly two-thirds of the donors gave samples on at least two occasions, making it possible to carry out longitudinal studies on vaccination- and infection-induced immunity. The biobank includes data collected at the time of blood donation (i.e., age, sex, region, medical conditions) and links these data with those of provincial registries of COVID-19 infections and vaccinations. Researchers can request access to the samples at biobanqueCOVID@hema-quebec.qc.ca. Additional details about the biobank are accessible in a scientific article published on the preprint server *medRxiv*.

Method for detecting recent infections in vaccinated persons

Seroprevalence studies are of great use in public health decision-making related to COVID-19. At Héma-Québec, these studies were conducted using samples from blood donors and serological tests developed by the organization's researchers. First-generation tests targeted the SARS-CoV-2 spike protein, but did not distinguish between immunity acquired through an infection and that acquired through vaccination. Second-generation tests targeted the nucleocapsid protein (N) but underestimated anti-N seroprevalence since vaccination reduces the anti-N response during infection.

A new approach was developed to assess seroprevalence based on a ratio of absorbance between a reference sample (pre-infection) and a test sample (post-infection). This method, the details of which are accessible in an article published on the preprint server *medRxiv*, significantly increases the sensitivity of the method to detect an infection in a given timeframe. The method has been in use since January 2022 to estimate the infection rate of the virus and its different variants in the Québec population.

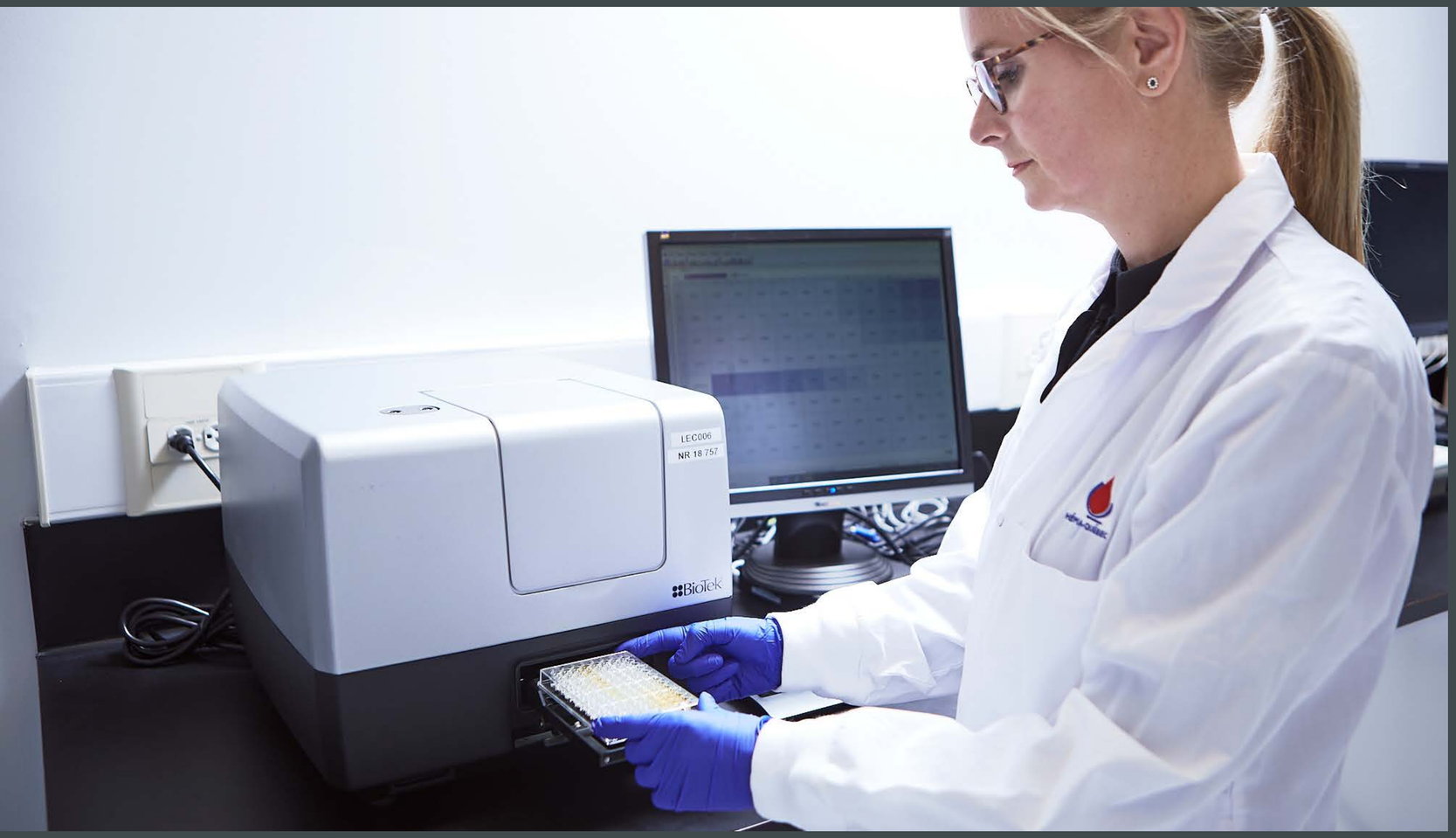
Continuation of the study on the seroprevalence of antibodies to SARS-CoV-2

Seroprevalence studies provide public health authorities with additional information that is essential to better estimate the proportion of the population that has developed some immunity to SARS-CoV-2. At four different times (or phases) of the pandemic, Héma-Québec has estimated the seroprevalence of antibodies to SARS-CoV-2 in Québec blood donors.

Unlike phases 1 and 2, which evaluated anti-spike seroprevalence, phases 3 and 4, conducted in collaboration with the Institut national de santé publique du Québec (INSPQ) and the ministère de la Santé et des Services sociaux (MSSS), evaluated anti-nucleocapsid (N) seroprevalence to isolate immunity acquired through an infection. Phase 3 revealed a 6.4% anti-N seroprevalence in blood donors. This seroprevalence, which was lower than that obtained during phase 2 (10.5% in unvaccinated donors), suggested that the method was no longer adequate for identifying past infections. The method described in the previous project was, therefore, used for the subsequent phases, which were carried out among blood donors from the PlasCoV biobank.

The seroprevalence of anti-SARS-CoV-2 antibodies has significantly increased in Québec since spring 2020.

This ratio-based approach revealed a 62.1% anti-N seroprevalence from December 2021 to August 2022 (i.e., the Omicron wave). In conclusion, the seroprevalence of anti-SARS-CoV-2 antibodies has significantly increased in Québec since spring 2020. Our results also suggest that a substantial proportion of infections are not detected by public health authorities.



Challenges related to conducting SARS-CoV-2 seroprevalence studies in blood donors

Blood donors are increasingly acknowledged for their support of epidemiological research, especially seroprevalence studies. However, these studies often differ in terms of design, which makes it difficult to interpret them.

This study highlights the heterogeneity of the methods used in seroprevalence studies.

To better understand how these differences can influence the results of seroprevalence studies, we reviewed such studies published in peer-reviewed journals between January 2020 and January 2021. Two reviewers extracted seroprevalence estimates and data on the population sampling methodology, frequency, test characteristics, and kinetics of the assayed antibodies. National data on the cumulative impact and social distancing policies were also extracted from accessible sources. At the end of 2020, seroprevalences were far from the collective immunity thresholds. In addition to differences in community transmission and various public health policies, the designs and methodologies of the studies likely contributed to the heterogeneity of seroprevalence estimates. This literature review was published in the journal *Vox Sanguinis*.

Studies on the humoral immunity to SARS-CoV-2

To quickly acquire knowledge on COVID-19, researchers at Héma-Québec combined their efforts and expertise with those of the Centre de recherche du Centre hospitalier de l'Université de Montréal (CRCHUM). The sharing of samples, technology and expertise on the characterization of the immune response to SARS-CoV-2 led to many breakthroughs, which have been published since April 2021. The time between the initial doses of the COVID-19 vaccine and their impact on the efficacy of the booster dose have been studied; the evolution of antibody affinity after a SARS-CoV-2 infection was also measured. In addition, studies are under way jointly with Yale University to examine antibody effector functions and their ability to neutralize the virus (using a murine model). This work has led to the publication of five articles (references 9, 22, 78, 79 et 80 in the Publications section).

Cross-reactivity of antibodies against the spike protein of the native, B.1.351, B.1.617.2 and P.1 SARS-CoV-2 strains in non-hospitalized individuals who contracted COVID-19

The scientific community was called upon to develop new technologies to solve problems related to the propagation of SARS-CoV-2. During the initial months of the pandemic, acquiring knowledge about the level of immunity to the virus in the population was critical.

The aim of this project, which brought together researchers from the Université de Montréal, the Centre hospitalier de l'Université Laval, and Affinité Instruments, was to develop a simple, rapid and portable method to detect (by surface plasmon resonance) the antibodies produced after SARS-CoV-2 infection or vaccination. The analytical performance of the method and its ability to characterize the strength of the interaction of the antibodies to the SARS-CoV-2 variants were evaluated. The antibody levels, and the pseudo-neutralization of the interaction between the SARS-CoV-2 spike protein and the ACE-2 human receptor were analyzed by testing the spike protein of the native strain and that of variants B.1.351, B.1.617.2 and P.1. The humoral immune response was strong, although a weaker response was observed against the variants. The results of this study were published in the journal *Scientific Reports*.

Prospective evaluation of the COVID-19 vaccine in organ recipients (PREVenT-COVID): a national strategy

While messenger RNA (mRNA) vaccines against SARS-CoV-2 have proven to be safe and effective in the general population, data show that immunocompromised, solid organ recipients have an altered immune response after one or two doses of the vaccine.

In a study carried out in collaboration with the Centre de recherche du Centre hospitalier de l'Université de Montréal (CRCHUM), the humoral immune responses were examined after the second and third doses of mRNA vaccines in kidney, liver, lung or heart recipients. Compared with naive SARS-CoV-2 immunocompetent healthcare workers (control group), the second dose induced a weaker humoral immune response in organ recipients, with the exception of liver recipients. A third dose stimulated humoral immune responses, albeit without reaching the levels of the control group. After a third dose, the neutralizing activity against the Delta and Omicron variants was weaker in organ recipients than in healthcare workers, but the effector functions mediated by the Fc receptors had similar levels in both groups. It remains to be seen whether these immune responses will be sufficient to protect organ recipients from the serious consequences that may arise from a SARS-CoV-2 infection. The results of this study were published in the journal *iScience*.

Humoral immune response to vaccination against the COVID-19 virus in frequent donors of apheresis platelets

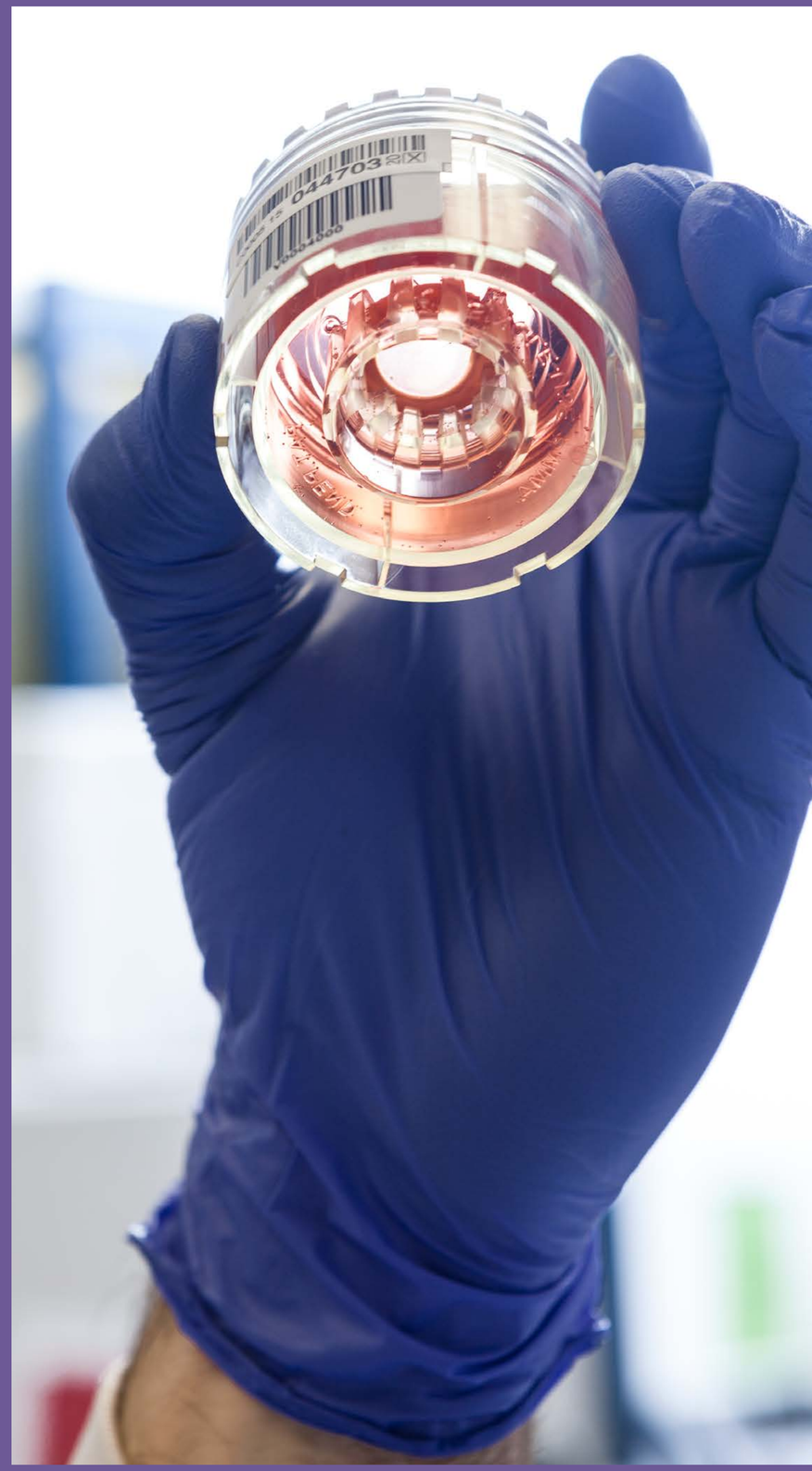
Recent studies have shown that some frequent donors of apheresis platelets (i.e., more than 20 donations per year for several years) present with T lymphocyte levels below the minimum acceptable threshold. Yet the other blood cells remain at normal levels. This lymphopenia persists for one to two years after stopping platelet donations, but is not accompanied by increased susceptibility to infections and cancers, suggesting that it does not harm the donors' immunity. However, the absence of the effect of lymphopenia on the immune ability of platelet donors has not been clearly demonstrated.

The aim of this project, led jointly with the Centre de recherche du Centre hospitalier de l'Université de Montréal (CRCHUM), was to study the immune ability of platelet donors presenting with T-cell lymphopenia, by comparing their response to the COVID-19 vaccine with that of less frequent platelet donors without lymphopenia. The immune response generated by vaccination was comparable between the donors with and without lymphopenia, suggesting that lymphopenia does not significantly affect the immune ability of frequent platelet donors. The exact causes of the lymphopenia, and the ways to mitigate it, are currently the subject of ongoing work. The results of this study were published in the journal *Transfusion*.

Estimation of the risk of SARS-CoV-2 transmission through corneal transplantation in Canada

The primary mode of SARS-CoV-2 transmission is from person to person through respiratory droplets. However, the virus has been found in the conjunctiva of infected persons. SARS-CoV-2 transmission through corneal transplantation is therefore theoretically possible, although no case has been reported to date.

The aim of this study was to assess the risk of SARS-CoV-2 transmission through corneal transplantation during the first wave of the pandemic in Canada, to better understand to what extent this risk could be reduced by testing deceased persons. At the height of the first wave of the pandemic, the estimated risk was 1 in 63,031 corneal transplants in Canada, but might have been as low as 1 in 175,821 or as high as 1 in 10,129. On average, one case of transmission might be observed every 16 years, assuming a community transmission equal to that at the height of the first wave. Testing donors would reduce the risk from 1 in 63,031 to 1 in 210,104, assuming a 70% test sensitivity. The theoretical risk of SARS-CoV-2 transmission through corneal transplantation is, therefore, extremely low, and it is unlikely that there would be a benefit to testing deceased donors. The results of this study were published in the journal *Cell and Tissue Banking*.



Impact of the microvesicles contained in convalescent plasma on the integrity of the lymphatic vascular system

The therapeutic use of convalescent plasma has garnered considerable attention since the start of the COVID-19 pandemic. However, clinical trials to assess the efficacy of convalescent plasma as a function of antibody concentrations have been inconclusive. Since vascular complications are a major concern in COVID-19 patients, maintaining the function of lymphatic vessels could potentially be considered in the formulation of an optimal convalescent plasma.

This study suggests that the secretion of extracellular vesicles by an altered endothelium could be an alarm signal that triggers a self-defense mechanism by the peripheral lymphatic vessels.

The objective of this study, conducted in collaboration with the Montreal Heart Institute, was to determine the characteristics of convalescent plasma that should be taken into consideration to limit the malfunction of the lymphatic endothelial cells (LEC) caused by inflammation. The results show that a donation made later after an infection tends to contain more pro-inflammatory cytokines and fewer extracellular vesicles (EV) derived from LEC. Thus, the secretion of extracellular vesicles by an altered endothelium could be an alarm signal that triggers a self-defence mechanism by the peripheral lymphatic vessels. These results, which were published in *Pharmaceuticals* and *Cells*, reveal a signature specific to convalescent plasma that would counteract the effects of excessive inflammation on the lymphatic endothelium. A simple and effective selection of convalescent plasma based on the time of donation would be essential to preserve the lymphatic and immune systems of infected patients.

Weak D type 42: antigen density and risk of alloimmunization in Québec

The weak D type 42 phenotype has a relatively high prevalence in Québec. To date, we do not know whether women expressing weak D type 42 are at risk of alloimmunization during pregnancy.

Weak D type 42 individuals may therefore be treated as D-positive individuals, which would limit the administration of anti-D immunoglobulins in pregnant women and the use of D-negative blood for transfusions.

The objective of this retrospective study was first to evaluate the risk of alloimmunization in pregnant women expressing weak D type 42, and then to measure the relative abundance of the D antigen on the surface of their red blood cells by flow cytometry. No case of alloimmunization has been reported. Furthermore, the abundance of the D antigen on the surface of weak D type 42 red blood cells was similar to that of red blood cells expressing weak D types 1, 2 and 3. These results suggest that weak D type 42 individuals can be treated as D-positive individuals. For pregnant women, this would limit the administration of anti-D immunoglobulins during pregnancy and the use of D-negative blood in the event of transfusion. The results of this study were published in the journal *Vox Sanguinis*.

A novel *KEL* null allele resulting from a c.223+1g>t mutation associated with an absence of the Kpb antigen in a First Nation donor

The Kell system, which consists of more than 36 antigenic variants, is one of the most diverse blood groups and is considered among the most important systems after ABO and Rh. Hence, antibodies targeting the Kell group must be considered clinically significant. When certain normally expressed antigens are absent, the individual is considered as having rare blood. The risk of alloimmunization becomes higher, and the probability of finding a compatible donor decreases.

We identified a First Nation donor carrying a novel *KEL null* variant. Given the rarity of this type of donor, serological and genetic analyses were done. This novel variant blocks the expression of Kell group antigens, including Kpb, which indicates the presence of rare blood. The novel intronic c.223+1g>t mutation was identified and added to international databases (ISBT and GenBank), and an article was published in the journal *Transfusion*. Current and future blood donations from this donor will be cryopreserved and added to Héma-Québec's rare blood bank.

Impact of the COVID-19 pandemic on unrelated stem cell donations in 2020: a report from the World Marrow Donor Association

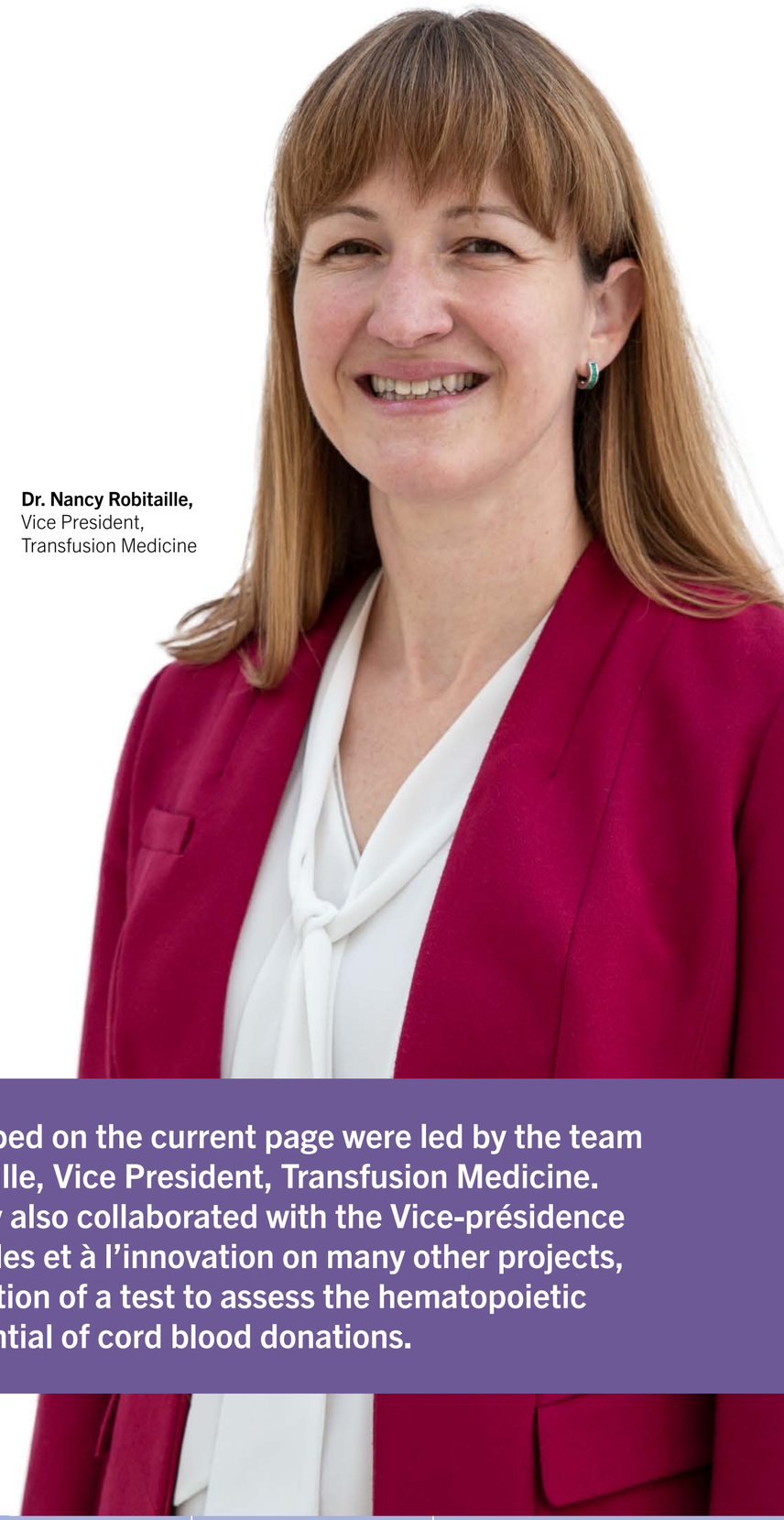
The COVID-19 pandemic affected several aspects of hematopoietic stem cell (HSC) donations and transplantations, which could have altered the collaboration between donor registries and transplant centres.

This study examined the effects of the COVID-19 pandemic on the number of unrelated HSC donations. On average, the number of unrelated HSC donations rose by 3.9% between 2015 and 2019, and fell by 3.5% between 2019 and 2020. The number of distributions of cord blood donations also decreased by 3.5%. The elements that ensured the continuity of operations were the quality and size of the registries and cord blood inventories, the robustness of the network of collection and transplantation centres, the ability to transfer patients and donors to hospitals in less affected regions, the use of national donors, a rapid and sufficient response to the challenges of international transportation, cooperation with national and international authorities, and collaboration with international colleagues. Despite the slight decrease observed, collaboration was remarkably well maintained, to the benefit of patients. The results of this study were published in the journal *Bone Marrow Transplantation*.

High prevalence of weak D type 42 observed in a mass RHD genotyping program in Québec

RhD phenotyping is vital to prevent alloimmunization, especially in women of child-bearing age. In 2016, an RHD genotyping program was established in Québec for women aged 45 and under with an atypical serological RhD.

A retrospective study was conducted among 2,105 women with an atypical RhD who were referred to Héma-Québec's Reference Laboratory between June 2016 and May 2020. Most of the women presented with at least a serological result of ≤ 2+ before being referred to Héma-Québec. Weak D type 42 was the most prevalent variant, representing 17.5% of all women tested. Only 15.3% of the women were type 1, 3.3% were type 2, and 8.6% were type 3. Weak D type 42 was highly expressed in regions with a low rate of immigration, known for their founder effects. This study, published in the journal *Transfusion*,shows that Québec has a unique *RHD* genetic distribution, characterized by a high prevalence of weak D type 42 due to a founder effect among the descendants of French colonists.



Dr. Nancy Robitaille,
Vice President,
Transfusion Medicine

The projects described on the current page were led by the team of Dr. Nancy Robitaille, Vice President, Transfusion Medicine. Her vice-presidency also collaborated with the Vice-présidence aux affaires médicales et à l'innovation on many other projects, including the validation of a test to assess the hematopoietic reconstitution potential of cord blood donations.

Research partnerships between blood services and public health authorities: an international, cross-sectional survey

The COVID-19 pandemic shed light on how blood services could partner with public health authorities to inform decisions. We explored how blood services partner with public health authorities on research projects.

A survey was sent to employees of blood services worldwide. The questions primarily pertained to partnerships with public health authorities, including the way in which data on donors and blood samples were used and collected. The employees of 27 blood services (at least one from each continent) responded. Fifteen (55.6%) indicated that their blood transfusion service was directly or indirectly supervised by public health authorities. Twenty-four (88.9%) indicated that they currently used or planned to use data or samples of blood donors for research and the surveillance of pathogens. Fourteen (51.9%) had established (or planned to establish) longitudinal cohorts; this number was 19 (70.4%) for biobanks. The majority of respondents were also involved (or planned to be involved) in research on the surveillance of pathogens. The results of this study were published in the journal *Vox Sanguinis*.

Adaptation to emerging trends in the supply and demand of red blood cell concentrates that are negative for certain blood group antigens

The use of packed red blood cells (pRBCs) is decreasing worldwide, but that of highly characterized pRBCs for minorities seems to be increasing. We do not know, however, if these trends may also be observed in Québec.

This retrospective study analyzed trends in the distribution of pRBCs (in general and for highly characterized pRBCs) and assessed the performance of the mass genotyping and recruitment strategy of donors from the Black community. The demand for pRBCs is declining, while that for highly characterized pRBCs remains stable. The study also drew up a list of the most requested phenotypic combinations and documented the efficacy of our mass genotyping and recruitment strategy of donors from the Black community. These results, which were published in *Transfusion*, support our ongoing efforts to better meet the future demand for pRBCs.

Consumption of water and salty snacks before donating to prevent vasovagal reactions

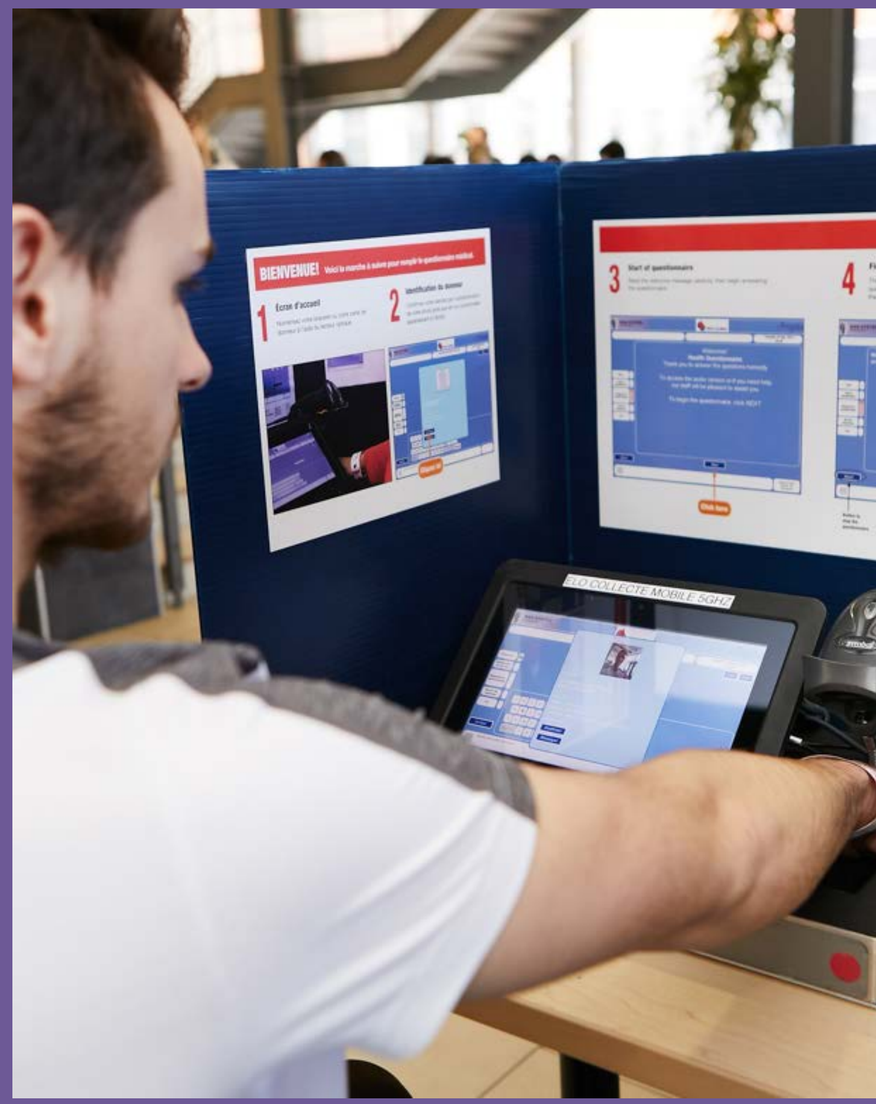
Reducing the risk of vasovagal reactions (VVR) can prevent incidents affecting donors and improve their rate of return. Taken individually, ingesting water and salty food could prevent VVR, but few studies have assessed the effect of their simultaneous ingestion.

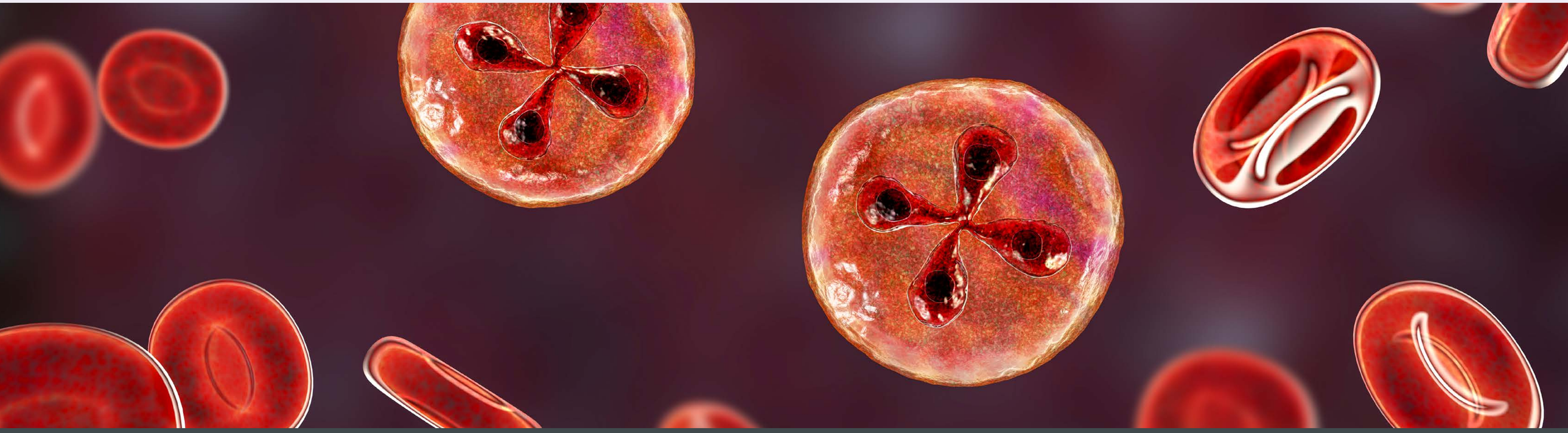
The aim of this study was to assess the effect of a VVR prevention program implemented in June 2017, which consisted of providing donors with water and a salty snack before giving blood, plasma or platelets. All donations collected during the "pre-program period" (i.e., November 2015 to November 2017), and the "post-program period" (i.e., December 2017 to November 2019) were included. The monthly rate of VVR (in general) went from 4.6% during the pre-program period to 4.3% during the post-program period, and never returned to its pre-program level. The analysis revealed a statistically significant and growing pre-program trend, a statistically significant immediate effect of the program, and a stable and non-statistically significant post-program trend. These results, published in the journal *Transfusion*, suggest that this new program durably reduced the incidence of VVR by approximately 15%.

Validation of new questions about the recent sexual behaviour of plasma donors and of men who have sex with men, without reference to their gender or sexual orientation

To remove the donor eligibility criterion for men who have sex with men (MSM), questions about risky sexual behaviours could replace those about sexual orientation, which would improve the inclusiveness of blood donation. We tested two ways of asking donors about their recent sexual behaviour.

The study comprised 126 donors of source plasma and 102 gay, bisexual or other MSM (gbMSM), including 73 cis gbMSM (which excluded non-binary MSM, genderqueer and trans persons). In the first scenario, participants were asked if they "had [. . .] had one or more new sexual partners" in the past three months. In the second scenario, they were asked if they "had had a new sexual partner" and if they "had had more than one sexual partner". The validation questions included more specific questions about the type of partners and sexual activity. The questions in the second scenario were better understood by the two groups that were studied. These questions were retained to develop the gender-neutral questionnaire. The results of this study were published in the journal *Transfusion*.





Reported compliance with pre-donation screening among blood donors

In June 2019, the deferral period after the last male-to-male sexual contact was reduced to three months in Canada. However, the effect of this change on non-compliance with pre-donation screening remains unknown.

As part of this change, we evaluated the non-compliance of blood donors with questions about male-to-male sexual contacts and other behavioural risk factors for human immunodeficiency virus (HIV). Among the vast majority of participants, the answers to these questions aligned with those given a few weeks later in an anonymous survey, suggesting excellent compliance. These results, published in the journal *Vox Sanguinis*, support the use of individualized approaches that focus on the risky behaviours of blood donors to improve the inclusiveness of blood donation.

Risk of transfusion-transmitted *Babesia microti* in Canada

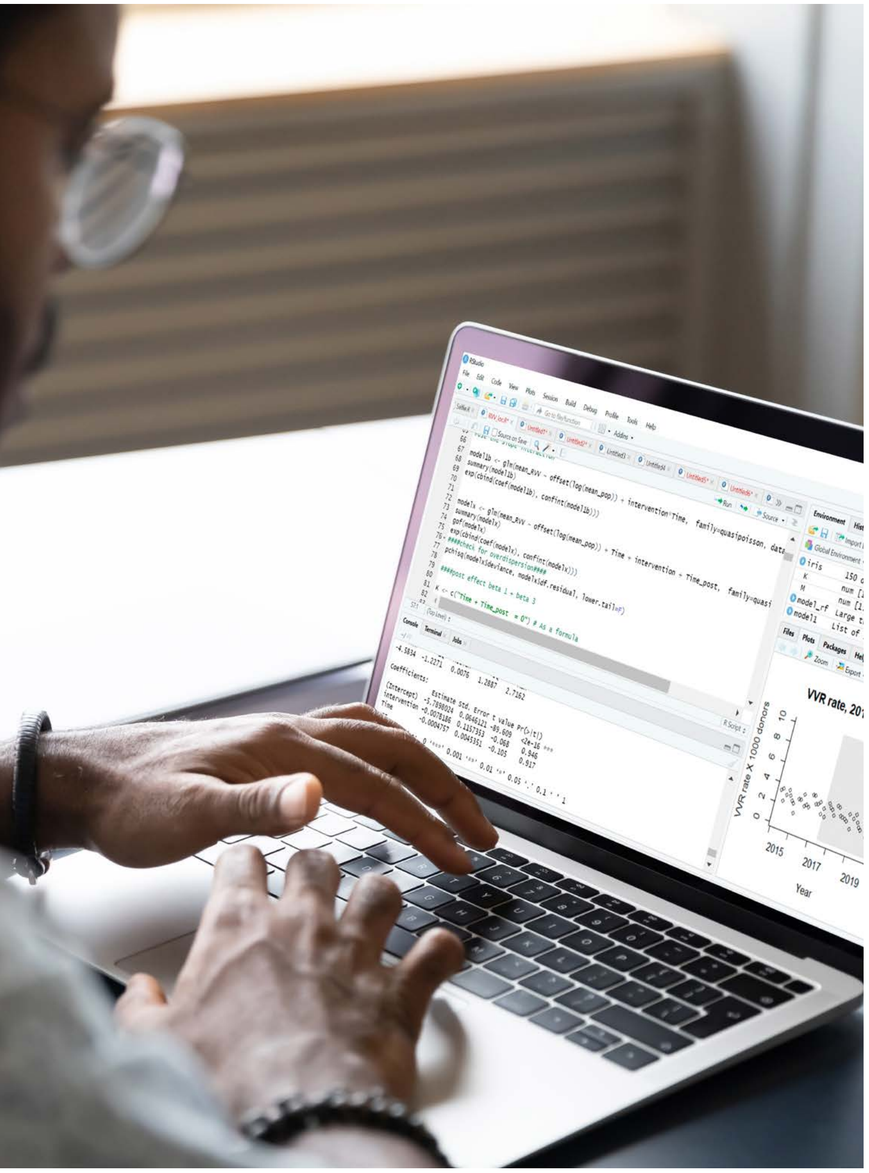
The distribution range of *Babesia microti* has expanded in Canada, in keeping with that of its vector tick. A *B. microti* infection can be transmitted through transfusion and be fatal in immunocompromised individuals.

The aim of this modelling project, a collaboration involving Canadian Blood Services, the Public Health Agency of Canada, and Héma-Québec, was to evaluate the risk of clinically significant babesiosis acquired through transfusion in Canada. The number of infected packed red blood cells was estimated based on three scenarios. Regardless of the scenario considered, fewer than five donations a year would test positive for *B. microti* using a nucleic acid test, and less than one donation would likely cause a clinically significant infection. The probability of clinically significant cases resulting from transfusion-transmitted babesiosis is therefore low, and testing all donations for *B. microti* would be of little benefit in Canada. However, the active surveillance of *B. microti* is recommended in vector ticks. The results of this study were published in the journal *Transfusion*.

HIV residual risk in Canada for apheresis source plasma donation without deferral for men who have sex with men

In June 2019, the deferral period since the last male-to-male sexual contact was shortened to three months in Canada.

This study modelled the residual risk of transmission of the human immunodeficiency virus (HIV) if: 1) pathogen reduction technology (PRT) was used for apheresis plasma donations; and 2) the deferral criterion for male-to-male sexual contacts was lifted. Without the deferral criterion, 3.01 out of 1 million donations would be HIV-positive, and no donation (in 300,000 lots that included two billion donations) would be HIV-positive after PRT treatment. These simulations suggest that the residual risk of HIV transmission is negligible for PRT-treated source plasma donations from men who have sex with men. The results of this study were published in the journal *Vox Sanguinis*.



This study indicates that deferrals for a recent tattoo or piercing reduce the number of donations collected and donor return rates.

Risk of transfusion-related acute lung injury and human immunodeficiency virus associated with donations from trans donors

The suppliers of blood products have established donor selection criteria to reduce the risks of transmission of infections and transfusion complications.

This study evaluated the risks of transfusion-related acute lung injury (TRALI) and of transmission of the human immunodeficiency virus (HIV) ensuing from donations by trans persons. The risks of TRALI and HIV were estimated on the basis of internal data and hypotheses from the literature. The trans population consisted of 134 donors, 94 (70.1%) of whom were trans men. The risk of having a donation causing a TRALI, knowing that it came from a trans man, was estimated at one every 115 to 999 years. The risk of having an HIV-contaminated donation, knowing that it came from a trans woman, was estimated at one every 1,881 to 37,600 years for all scenarios. This study, published in *Vox Sanguinis*, suggests that donations from trans persons are associated with a negligible risk of TRALI and HIV.

Whole blood donor return rates after deferral for tattooing or body piercing: a BEST survey study conducted with blood services

In order to limit the risk of infections transmitted through transfusion, blood donors who recently received a tattoo or piercing are deferred from donating.

Héma-Québec took part in an international study led by Sanquin and Canadian Blood Services to determine the proportion of donors deferred from giving blood due to a recent tattoo or piercing, as well as the return rates of these donors following the deferral period. Eight suppliers of blood products (all members of the Biomedical Excellence for Safer Transfusion – BEST or the European Blood Alliance – EBA) took part in a survey on deferrals for tattooing and piercing, as well as on return rates in 2017. The deferral rates were generally lower in repeat donors than in new donors. Women and young donors were more often deferred than men and older donors. Men were more unmotivated by tattoo or piercing deferral, resulting in lower return rates in men compared to women. The return rates varied greatly from one supplier to another. This study, published in *Vox Sanguinis*, indicates that deferrals for tattooing and piercing decrease the number of donations collected and the rates of return of donors. Reducing the duration of the deferral period for tattoos and piercings could mitigate this impact, which could be assessed using studies conducted among individual suppliers of blood products.

Cost-effectiveness analysis of pathogen reduction technology in Québec

Pathogen reduction technology (PRT) decreases the risks of transfusion transmission of several pathogens that might contaminate blood donations. PRT could act as an additional barrier in the event of a new, emerging pathogen transmissible by transfusion. In Québec, it is unknown whether the benefits of this technology justify its cost, given that the last cost-benefit analysis dates back to more than 10 years.

An analysis was done to simulate the costs (measured in 2020 dollars) and benefits (measured in quality-adjusted life years – QALY) tied to the implementation of PRT at Héma-Québec, in the presence or absence of fictitious new pathogens with epidemiological characteristics similar to those of human immunodeficiency virus (HIV) or West Nile virus (WNV). In the baseline scenario, the incremental cost-effectiveness ratio (ICER) was $8,088,974/QALY gained. In the presence of an HIV-like pathogen, the ICER ranged from $123,063 to $1,274,445/QALY gained, depending on the assumed contagiousness. In the presence of a WNV-like pathogen, the ICER ranged from $6,652,769 to $7,469,167/QALY gained, depending on contagiousness.

This study, published in the journal *Transfusion*, shows that the ICER of PRT is more favourable in the presence of a blood-borne emerging pathogen. This possibility should be considered when deciding whether the implementation of PRT is beneficial.

Innovation

Standardization of a flow cytometry serologic test to detect antibodies directed against SARS-CoV-2

A rapid flow cytometry test to detect anti-SARS-CoV-2 antibodies was previously developed by Héma-Québec. However, this test had not yet been standardized for the purpose of implementation in other laboratories.

The present study evaluated the performance of this flow cytometry test, and also optimized and standardized it to facilitate its transfer. The test proved to be effective, and a standardized protocol was developed. In its proposed form, this test could be implemented by any flow cytometry laboratory that wishes to use it.

Active seeking of information to minimize the risks to the safety of blood transfusions: a pilot project in the context of the COVID-19 pandemic

At the start of the pandemic, the transmissibility of SARS-CoV-2 through transfusion was unknown.

As part of a pilot project carried out from May 1 to 2, 2020, donors were contacted three days after their donation to assess their COVID-19 symptoms. Half of the donors responded to the three questions on a short questionnaire; the other half responded to a more detailed questionnaire. The blood products were withdrawn if the donors presented with symptoms suggesting COVID-19. Of 654 donors, 609 (93.1%) were successfully contacted. Of the 310 respondents to the short questionnaire and 299 respondents to the long questionnaire, 19 (6.1%) and 8 (2.7%) respectively presented with one or more symptoms. Two donations (0.3%) had to be withdrawn after assessment by specialized nurses. These results, which were published in the journal *Vox Sanguinis*, suggest that the post-donation, active seeking of information could be done to mitigate emerging and undocumented transfusion risks.

Development of a rapid screening test for IgA deficiency and the presence of anti-IgA

An individual is considered to have IgA deficiency if the person's IgA levels are below 500 ng/ml. IgA deficiency can cause serious transfusion reactions in the presence of anti-IgA antibodies, especially anaphylactic reactions. At Héma-Québec, IgA deficiency is determined using an ELISA test, but the technique requires several hours of preparation.

The objective of this project was to develop a rapid screening test to assess IgA levels and detect anti-IgA, thereby identifying donors with IgA deficiency. The new test is done by flow cytometry and uses mouse immunoglobulins targeting IgA or anti-IgA IgG antibodies. There was an almost perfect match between the results obtained by ELISA and those obtained by flow cytometry for the detection of both IgA and anti-IgA. This test is currently undergoing additional verifications with a view to implementing it.

Development of a method for detecting filamentous fungi in cord blood units

This project aimed to develop an effective method for detecting filamentous fungi in units of cord blood, a requirement of the Netcord standard — Foundation for the Accreditation of Cellular Therapy (FACT). Units of cord blood were inoculated with the filamentous fungus *Aspergillus brasiliensis* and processed into sub-products (white blood cells, plasma and red blood cells). After 24 and 72 hours of incubation at room temperature in pouches of residues and red blood cells, agars were seeded with part of the content of the pouches and incubated seven days at 30°C. Our results show that the detection of *A. brasiliensis* is optimal during sampling of the pouch of red blood cells. The detection of the fungus is not affected by a storage time of 72 hours following processing of the cord blood. The technology transfer of this method to the Product Qualification Laboratory is planned for January 2023.

Quality, safety and efficacy of the products

Neutrophil function in granulocyte concentrates from donors stimulated with prednisone or G-CSF: effects of the stimulation, granulopheresis and storage

The transfusion of granulocyte concentrates is indicated for neutropenic patients with a life-threatening infection that does not respond to conventional treatments. Currently, the only criteria regulating the production of granulocyte concentrates are the number of neutrophils and the sterility of the product; antimicrobial activity is not verified.

The aim of this study was to characterize the neutrophils contained in granulocyte concentrates isolated in persons having made two donations: a first one during which they were stimulated with prednisone, and a second one six months later during which they were stimulated with G-CSF. Compared with neutrophils from G-CSF-stimulated donors, those from prednisone-stimulated donors showed higher levels of phagocytosis and chemotaxis, and a lower production of IL-8. The function of neutrophils from prednisone-stimulated donors, but not that of neutrophils from G-CSF-stimulated donors, was altered by apheresis: intracellular calcium mobilization was significantly reduced, and the production of intracellular reactive oxygen species was significantly increased. There were more neutrophils in G-CSF-stimulated donors than in prednisone-stimulated donors. However, 40% of neutrophils from G-CSF-stimulated donors were immature, whereas none of those from prednisone-stimulated donors were immature. Furthermore, storage significantly reduced the viability and antimicrobial functions of neutrophils from G-CSF-stimulated donors, but not those of prednisone-stimulated donors, probably because of their high concentration. Functional tests and better storage conditions for granulocyte concentrates could improve their quality.

An international consortium evaluating a new method to measure the regenerative potential of hematopoietic stem cells: the IL-3-pSTAT5 test

Measuring the regenerative potential of cryopreserved stem cells is essential for the quality control of transplant products. We previously developed an alternative to the conventional test (the IL-3-pSTAT5 test), but its interlaboratory performance remained to be validated.

An international multicentre study was conducted with the support of many worldwide partners to assess the interlaboratory performance of the IL-3-pSTAT5 test and complete its validation. The performance of the test was excellent, the validation was completed, and all the performance criteria were met. This study, the results of which were published in the journal *Transfusion*, positions the IL-3-pSTAT5 test as an adequate and effective alternative to the conventional test for hematopoietic transplant laboratories that would wish to implement it.

Preparation of plasma and serum from cord blood, and characterization of growth factors contained in these derivatives

Alternative uses for cord blood must be explored to maximize our use of this source of stem cells. To date, the characteristics of plasma and serum from cord blood processed by Héma-Québec remain ill-documented.

The aim of this study was to develop a standardized method for preparing plasma and serum from cord blood and to measure the concentration of growth factors in the serum and plasma derived from cord blood. Our results show that several products can be derived from cord blood. Determining the concentration of growth factors also made it possible to assess the richness of the blood for each of these derivatives, as well as the complexity and yield of each of the preparations. This approach to preparing derivatives from cord blood opens the door to the production of new products from this biological source.

Efficacy of two disinfections using a 5% povidone iodine solution on microorganisms placed on a filter, and the effect of a treatment at 35 °C on the natural contaminants of corneas stored in Optisol-GS

Several eye banks now expose eyeballs twice (rather than once) to povidone iodine to better prevent infectious complications of corneal transplants, and some also heat the Optisol-GS storage solution to 35 °C to increase the quality of the specular images. Additional data are needed, however, to support these changes in practice.

The first objective was to document the efficacy of two exposures to povidone iodine at the time of initial collection. After two exposures to povidone iodine, the average microbial load of contaminants of interest was only 0-2 colony-forming units/ml, and two out of 10 corneas contained an unacceptable microorganism (*Staphylococcus aureus*). After implementation of a second exposure to povidone iodine at Héma-Québec, the positivity rate of the pre-surgical culture for unacceptable microorganisms went from 6.0% to 1.3%.

The second objective was to explore the possibility of incubating the corneas at 35 °C. Contaminants of interest were subjected to temperature transitions mimicking an operating procedure with warming at 35 °C and specular analyses. The average microbial loads were negligible after 7 to 14 days of incubation, except for *Candida albicans*. Corneas were also incubated for 7 days at 4 °C or subjected to temperature transitions (with incubation at 35 °C). A growth in the broths was observed in 2 of 9 corneas kept at 4 °C, and in none of the 9 corneas subjected to temperature transitions.

The addition of a second disinfection with povidone iodine and warming at 35 °C reduce the microbial load of corneas, which could translate into a reduction in the rejection rates of corneas.

Impact of transport in thermoregulation systems on the quality of whole blood donations

After collecting blood donations, it is essential to maintain optimal transportation conditions to ensure product quality. The thermoregulation system used to transport donations to Héma-Québec ensures rapid chilling of the collection pouch after blood collection. However, the system does not meet the manufacturers' requirements, based on recent performance evaluations of the collection devices.

The aim of this project is to develop a thermoregulation system that meets the expectations of Héma-Québec's operational sectors (i.e., extend transportation time) and complies with Canadian Standards Association (CSA) standards and manufacturers' requirements. Using vacuum insulation panel (VIP) components and a strategic combination of phase change materials, blood products were transported in a compliant manner over a period of >24 hours. The system was later used in extreme outdoor weather conditions, and the products all complied with CSA quality control standards after processing. The thermoregulation system is currently in the process of being validated, while an improved version is being developed as part of the continuous improvement process.

Comparison of the performances of different analytical methods to determine the quantity of fibrinogen in cryoprecipitates

Blood services measure the concentration of fibrinogen in cryoprecipitates to control their quality. The Canadian Standards Association (CSA) stipulates that 75% of the products tested must contain ≥150 mg of fibrinogen per cryoprecipitate. While the Clauss test is considered to be the reference method for measuring the concentration of fibrinogen, the prothrombin time test (PT-Fib) remains widely used. Significant variations have been observed between the values reported by blood product suppliers internationally, without any major differences in the preparation methods.

The aim of this study, conducted in collaboration with Canadian Blood Services, was to compare the methods for preparing cryoprecipitates and the methods for analyzing fibrinogen used by two blood services. The results show that the PT-Fib test carried out using a photo-optical detection device tended to overestimate the values compared with the Clauss test carried out using an electromechanical detection device. Conversely, the Clauss test generated higher values than the Pt-Fib test when they were both carried out using the same photo-optical detection device. The study shows that the choice of analyzer can impact the values obtained.

Multicentre study of cryoprecipitates: a BEST study

International standards require that cryoprecipitates contain a minimum quantity of fibrinogen to ensure that the products are appropriate for clinical use. However, there is no consensus as to the manufacturing process and the method for measuring fibrinogen. Internationally, cryoprecipitate units prepared by different blood services can contain variable quantities of fibrinogen, despite a comparable starting volume of plasma.

The Biomedical Excellence for Safer Transfusion (BEST) launched a study in which nine partners, including Héma-Québec, collaborated to better understand variations in the quantities of fibrinogen in cryoprecipitates between different blood services. Each centre participated in preparing units of cryoprecipitates and determined their fibrinogen content based on their standardized operating procedures. Samples of each product were also sent to the NHS Blood and Transplant (United Kingdom) to centralize the analyses for comparison purposes. The results of this study will soon be published.

Effect of cannabinoids on the quality of blood components

Approximately 14% of blood donors consume cannabis and are not excluded from donating blood based on the criteria in effect in Canada. This high prevalence raises concerns about the potential impact of cannabis consumption on the quality of blood products.

This study assessed the effects of a cannabinoid mixture on the quality of red blood cells and platelets, from their collection to their storage. To mimic cannabis consumption prior to blood donation, whole blood was exposed to variable concentrations of a cannabinoid mixture. The whole blood was then separated into red blood cells and platelet-rich plasma (PRP). Hemolysis and methemoglobin levels were significantly higher in red blood cells exposed to a cannabinoid mixture than in control red blood cells, immediately after processing and throughout storage. In addition, the number of platelets, CD62P expression and platelet aggregation were significantly lower in the PRP exposed to the cannabinoid mixture compared with the control PRP.

These results, which were published in the journal *Blood Transfusion*, suggest that cannabis consumption prior to blood donation could alter the quality of the blood products. However, more studies are necessary before modifying eligibility criteria, which require that donors be capable of providing informed consent at the time of donation.

Support to operations

Evaluation of the performance of Fresenius Kabi's CompoLab TM hemoglobin analyzer

As part of a call for tenders' process, this project evaluated the analytical performance of the CompoLab TM device (from Fresenius Kabi) for measuring hemoglobin levels. The precision and repeatability of the analytical method were evaluated. Its concordance with a reference value (i.e., its accuracy) was also evaluated. The precision and accuracy of the equipment were both above 97%. In a blood collection setting, the CompoLab TM overestimated hemoglobin levels by 0.4 g/dL. However, in the case of donors presenting hemoglobin values of ≤140 g/dL, the device underestimated the values by 0.03 g/dL, which could increase the exclusion rate of donors whose hemoglobin level is in the region of the critical eligibility threshold. Fresenius Kabi's CompoLab TM analyzer was deemed to have met the technical and operational requirements described in the call for tenders and was implemented in Héma-Québec's operations in the spring of 2022.

Proposals for replacing the Ac-T 5diff CP hematology analyzer used before granulocyte donations by apheresis

At Héma-Québec, a complete blood count is done using a hematology analyzer before each collection of granulocytes. The aim of this step is to program the automated Spectra Optia TM apheresis system and optimize the donation based on the donor's hematocrit and neutrophil concentration. The two hematology analyzers at the GLOBULE Centre in Laval are seldom used, since they only serve for granulocyte collections. The manufacturer recommends regular maintenance procedures for the device to ensure that it is in good working order. The devices thus become difficult to calibrate and maintain.

A literature review, an identification of the devices currently on the market, and a benchmarking were done to draw up a list of hematology analyzers that would be best adapted to the reality of the GLOBULE Centre in Laval. Various solutions were explored. The more compact models reduce the need for maintenance since they leverage single-use tubes that contain all the reagents and components needed for the tests, calibration and maintenance. In addition, they require very low volumes of blood while generating results of comparable precision. From the standpoint of donor appreciation and comfort, the HemoCue WBC DIFF device makes it possible to replace a venipuncture with a capillary puncture. The neutrophil counts obtained with this device had a higher than 90% correlation with those obtained with the current device. The results were sufficiently reliable and precise for this device to be used at the GLOBULE Centre in Laval. The device is compact and portable and does not require maintenance, but it is not approved by Health Canada. Héma-Québec continues to follow this file and keep an eye out for other emerging technologies.

Replacement of applicators soaked with chlorhexidine gluconate and povidone iodine to mitigate inventory shortages

The puncture site of donors is disinfected by applying a solution of chlorhexidine gluconate or, for allergic individuals, a solution of povidone iodine. Twice during the year, however, there was an inventory shortage of applicators pre-soaked with these solutions. Different applicators had to be used to mitigate the situation.

These alternative applicators were validated by applying an agar against the folds of the elbows of volunteer donors before and after disinfection. The efficacy of the disinfection was then assessed by counting colony-forming units on agar. The two methods showed results similar to those of conventional methods, and were thus used to mitigate the inventory shortage.

Pasteurization monitoring: overview of devices available on the market and replacement solutions for Holder pasteurization

Pasteurization ensures the safety of the milk in mother's milk banks. Holder pasteurization is the method of reference used in most milk banks. However, studies show that this method leads to a loss of important bioactive factors when the milk is heated above 57 °C. Several precautions are therefore in order: the milk must be quickly heated to 62.5 °C for 30 minutes (by adequately controlling the maximum temperature plateau), after which it must be quickly cooled.

The aim of this study was to gather information on the pasteurization devices used in other milk banks and to compare them to that used at Héma-Québec. The devices available on the market were identified, the literature was reviewed, and a benchmarking of other banks was done. Only one device showed optimal control of the pasteurization parameters, but its capacity of 63 bottles per treatment was substantially below the needs of Héma-Québec's milk bank. The literature review also identified alternatives to Holder pasteurization, i.e., pasteurization at high temperature for a short period of time, and pasteurization at high pressure and ultraviolet radiation. Each of these methods has its own benefits and drawbacks, and their ability to provide safe quality milk deserves to be studied further. Constant monitoring is under way to keep abreast of new technological developments.

Replacement of the box used to transport blood products in hospitals

This project is part of a collaboration between Héma-Québec and the ministère de la Santé et des Service sociaux (MSSS). The aim is to identify needs and prepare specifications leading to the acquisition and, subsequently, the evaluation of the performance of new thermoregulation systems adapted for the transport of blood products in hospitals. In a preliminary phase of this project, the Research Division was approached to act as consultant and share its expertise on the cold chain and the development of boxes to transport blood products under various conditions.

One of the first phases of the project set out to characterize the thermoregulatory performances of the systems currently used by hospitals. The purpose of this step was to evaluate variations between the performance of current methods versus the desired performance, to better define needs and develop technical specifications for a call for tenders which will lead to the acquisition of a thermoregulation system. This study identified the issues linked to current thermoregulation systems and proposed solutions to the MSSS. This will enable the MSSS to better define its expectations regarding the next system for transporting blood products.

Change to the package insert of nutritional values in mother's milk

Information about the nutritional values of mother's milk distributed by Héma-Québec is found in a package insert accompanying the delivery of each lot of milk to hospitals. Medical staff use this information to properly fortify the banked milk and ensure the optimal growth of infants.

In 2015, the nutritional values of 30 lots of milk were analyzed by an external firm to determine the values (fixed for all the lots) indicated on the package insert. The values obtained ranged from 52 to 80 cal/100 ml, and the 90th percentile (i.e., 70 cal/100 ml) of this range was posted on the package insert to ensure compliance with the Canadian Food Inspection Agency (CFIA) standard (i.e., calorie content <120% of the value indicated). However, with this method, 90% of the lots of milk had an overestimated calorie content, and the milk was not properly fortified in the hospitals. In 2021, a new analysis of 30 lots of milk gave similar results (i.e., values ranging from 58 to 73 cal/100 ml), but the CFIA standard could be complied with by posting the median of these lots on the package insert. The proportion of lots with an overestimated calorie content thus went from 90% to 50%. As a result, the package insert was modified to provide this new information to neonatalogists.

Evaluation of the performance and operational impacts associated with the migration of the control software and settings of the apheresis collection device (Trima v7.0)

At Héma-Québec, more than 85% of platelet concentrates are collected by apheresis using Trima Accel technology (Terumo BCT). In March 2019, Terumo BCT announced that the Trima and Vista control softwares would be migrating to Trima v7.0 and Vista v4.2 in December 2021. In addition, these updates were accompanied by a change in collection devices.

The products obtained with Trima v7.0 were of equivalent quality, if not slightly higher, to those obtained with Trima v6.0.

The aim of this study was to evaluate the performance of apheresis collection following the migration of Trima v6.0 to Trima v7.0, with regards to both the collection process and product quality. A study was conducted to compare the quality markers of platelet products obtained with Trima v7.0 with those obtained previously with Trima v6.0 (historical values) for the same cohort of participants. The results showed that the products obtained with Trima v7.0 were of equivalent quality, if not slightly higher, to those obtained with Trima v6.0, although their platelet concentrations were slightly lower. The new version of the Trima control software was introduced in all GLOBULE centres in the spring of 2022.

Other support to operations

- The use of VIP packaging with a polyethylene insert enabled the cooling speed of collection pouches to be reduced and the time limits for transporting whole blood to be relaxed.
- A replacement format for thermoregulating bags was evaluated for the transport of products at room temperature.
- For collection volumes of 465 ml, the temperature profiles of blood donations transported in a VIP thermoregulating system were shown to comply with the requirements of the Canadian Standards Association (CSA).
- The quality of whole blood pouch agitators (used for controlling the collection volume) was evaluated.
- During platelet donations, cells remain trapped in the leukocyte reduction cone, and a procedure is used to dislodge them after a certain volume of blood is processed. This procedure, which enables immune cells to be returned to the donor, could alleviate the lymphopenia observed in some frequent platelet donors. However, a study revealed that a large number of cells remain trapped in the cone despite the procedure, making its use inadequate for alleviating lymphopenia.
- The removal of air from the blood pouch by the PCS2 device could be risky for donors (inadvertently) left under perfusion. Preventive measures were implemented to minimize this risk.
- A visual inspection guide was developed to identify the presence of free hemoglobin in plasma and spillage of red blood cells during the collection of source plasma with the PCS2 device.

Outreach

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Guest lectures, papers presented at conferences, workshop facilitation

Keystone eSymposia—Innate Immunity: Mechanisms and Modulation; April 12—15, 2021 (virtual event)

Oral Presentation

Murru A, Allard MÈ, Paré G, Boyer L, Cayer MP, Vitry J, Landry P, de Grandmont MJ, Robitaille N, Branch D, Labrecque MM, Girard M, Fernandes MJ. "Assessment of neutrophil function in granulocyte concentrates used to treat life-threatening infections."

Canadian Society for Transfusion Medicine (CSTM) annual conference; May 13—15, 2021 (virtual event)

Guest Lectures

Bazin R. "COVID-19 antibodies."

Trépanier P. "R&D duties during a pandemic 2020s tale."

Oral Presentation

Cayer MP, de Grandmont MJ, Ducas É, Robidoux J, Laforce-Lavoie A, Dussault N, Landry P, Fonseca S, Djaileb A, Jodaylami MH, Pelletier J, Live L, Boudreau D, Masson JF, Brouard D. "One night in Québec… Collaborative projects at interdisciplinary borders."

Posters

Cayer MP, Laforce-Lavoie A, de Grandmont MJ, Schubert P, McTaggart K, Brouard D. "Performance evaluation of a non-destructive quality control technology for red blood cell concentrates."

Fonseca S, Cayer MP, Ahmmed KMT, Khaden-Mohtaram N, Brouard D. "Antibacterial activity of a SiO2 nanoparticle coating to improve blood product safety."

Murru A, Allard MÈ, Paré G, Boyer L, Cayer MP, Vitry J, Landry P, de Grandmont MJ, Robitaille N, Branch D, Labrecque MM, Girard M, Fernandes M. “Evaluation of the quality of granulocyte concentrates collected for transfusion of neutropenic patients.”

3rd Young Tunisian Researchers in Biology (YTRB) Network International Symposium; May 20–22, 2021 (virtual event)

Oral Presentation

Fonseca S, Cayer MP, Brouard D, Charrette S, Ahmmed KMT, Khadem-Mohtaram N. “Antibacterial activity of a SiO2 nanoparticle coating to improve blood product safety.”

Research day of the Faculty of Medicine and affiliated centres; May 27, 2021 (virtual event)

Poster

Murru A, Allard MÈ, Paré G, Boyer L, Cayer MP, Vitry J, Landry P, de Grandmont MJ, Robitaille N, Branch D, Labrecque MM, Girard M, Fernandes MJ. “Évaluation de la fonction des neutrophiles mobilisés dans les concentrés de granulocytes produits au Canada pour le traitement d’infections chez des patients neutropéniques.”

International Symposium – Neutrophil 2021; May 31–June 1, 2021 (virtual event)

Poster

Murru A, Allard MÈ, Paré G, Boyer L, Cayer MP, Vitry J, Landry P, de Grandmont MJ, Robitaille N, Branch D, Labrecque MM, Girard M, Fernandes M. “Characterization of neutrophils in prednisone-derived and G-CSF derived granulocyte concentrates used to treat life-threatening infections.”

Cell Therapy Transplant Canada (CTTC) 2021 Annual Conference; June 13–16, 2021 (virtual event)

Guest Lectures

Baillargeon N. “Population study in partnership with First Nations to address the challenge of diversity.”

Laganière J. “Genome editing in hematopoietic stem cells.”

Posters

Margaillan G, Dumont N, Rouleau P, Drouin M, Laganière J. “Direct assessment of HSC potency in fresh cord blood via an IL-3-based assay.”

Trépanier P, Simard C, Rhéaume MÈ, Fournier D. “Rapid assessment of autologous peripheral-blood stem cells potency by intracellular flow cytometry.”

Cord Blood Connect Conversations; September 1, 2021 (virtual event)

Workshop

Trépanier P. “A conversation about transient warming events.”

4th Annual Cord Blood Connect: The International Congress for Cord Blood and Perinatal Tissue Research 2021; September 23–30, 2021 (virtual event)

Poster

Bazin R, Simard C, Fournier D, Trépanier P. “Results of a multicenter evaluation of a rapid flow cytometry potency assay for cryopreserved cord blood units: a BEST Collaborative study.”

Foundation for the Accreditation of Cellular Therapy (FACT) Cord Blood Inspection and Accreditation Workshop and Quality Boot Camp; September 29, 2021 (virtual event)

Workshop Facilitation

Baudoux E, Mahmud N, Johnson P, Querol-Giner S, Kalouche E, Fournier D. “Quality boot camp panel discussion.”

AABB 2021 Virtual Annual Meeting; October 17–19, 2021 (virtual event)

Oral Presentations

Ducas É, Laforce-Lavoie A, Delorme A, Live L, Pelletier J, Masson JF, Brouard D. “Point-of-care surface plasmon resonance system for IgA immunodeficiency screening and anti-IgA detection in serum.”

Tremblay T, Perreault J, Rouleau P, Simard C, Allard MÈ, Laumaea A, Finzi A, Lewin A, Bazin R. “Response to COVID-19 vaccination in lymphopenic apheresis platelet donors.”

Posters

Baillargeon N, Éthier C, Boileau M, Dégarie M, Latour C, Constanzo-Yanez J, Leiva-Torres GA, Lavoie J. “High-frequency antibodies anti-Lu5 identified in a pregnancy follow-up: a case study.”

Caffrey N, Lewin A, Delage G, Renaud C, Yi QL, Drews SJ, O’Brien SF. “Prevalence of Chagas disease among donations to Canadian blood agencies (2009-2020).”

Cayer MP, de Grandmont MJ, Ducas É, Djaileb A, Jodaylami MH, Live L, Pelletier J, Masson JF, Boudreau D, Brouard D. “Direct SARS-CoV-2 antibody detection in clinical samples using a portable surface plasmon resonance method and a reference ELISA assay.” Prix pour l’une des meilleures présentations par affiche.

Cayer MP, Laforce-Lavoie A, de Grandmont MJ, Schubert P, McTaggart K, Brouard D. “Non-destructive quality control technology for red blood cell concentrates: a performance evaluation.”

Cognasse F, Hamzeh-Cognasse H, Eyraud MA, Prier A, Arthaud CA, Tiberghien P, Begue S, de Korte D, Gouverok E, Greinacher A, Aurich K, Noorman F, Dumont L, Kathleen K, Drouin F, Cloutier M, de Grandmont MJ, Bazin R, Cardigan R, Huish S, Smethurst P, Devine D, Schubert P, Johnson L, Marks DC. “Assessment of the soluble proteins HMGB1, CD40L and CD62P during various platelet preparation processes and the storage of platelet concentrates: an international study.”

Fonseca S, Cayer MP, Ahmmed KMT, Khadem-Mohtaram N, Brouard D. “Antibacterial nanoparticle coating: a proactive approach for blood and patient safety.” Prix pour l’une des 10 meilleures communications par des étudiants, catégorie Undergraduate/Nursing/MLS student.

Leiva-Torres GA, Drouin M, Constanzo-Yanez J, Chevrier MC, Therrien R, Taillefer C, Robitaille N, Laganière J. “Evaluation of noninvasive fetal RHD genotyping kits using maternal plasma.”

Murru A, Allard MÈ, Paré G, Boyer L, Cayer MP, Vitry J, Landry P, Robitaille N, Branch D, Labrecque MM, Girard M, Fernandes MJ. “Characterization of neutrophils in prednisone-derived and GSF-derived granulocyte concentrates used to treat life-threatening infections.”

24th Chemistry and Biochemistry Graduate Research Conference (CBGRC); November 19, 2021 (virtual event)

Oral Presentation

Fonseca S, Cayer MP, Ahmmed KMT, Khadem-Mohtaram N, Brouard D. “Antibacterial nanoparticle coating: a proactive approach for blood and patient safety.”

Conference on Retroviruses and Opportunistic Infections (CROI) 2022; February 12–16, 2022 (virtual event)

Poster

Tauzin A, Gong SY, Beaudoin-Bussières G, Marchitto L, Laumaea A, Nayrac M, Sannier G, Bazin R, Richard J, Côté M, Tremblay C, Duerr R, Martel-Laferrière V, Kaufmann DE, Finzi. “A long

interval vaccine regimen leads to strong humoral responses against SARS-CoV-2."

AMMI Canada – CACMID Annual Conference 2022, Vancouver, Canada, April 5–8, 2022

Oral Presentation

Drews SJ, O'Brien S, Lewin A, Renaud C. "Blood Operators One Health Session: The role of blood operators in supporting One Health and engaging infectious diseases experts, medical/clinical microbiologists and public health laboratorians."

Posters

Lewin A, Bazin R, Boivin A, Renaud C, Germain M. "Cohort profile: A plasma donor biobank to study immunity to COVID-19 (PlasCoV)."

Lewin A, Grégoire Y, Bazin R, Germain M, Delage G, Renaud C. "Seroprevalence of SARS-CoV-2 antibodies among blood donors in Québec: results of phases 1 and 2 of a serial cross-sectional study."

O'Brien SF, Reedman C, Yi QL, Osiowy C, Bolotin S, Lourenco L, Binka M, Lewin A, Drews SJ. "Hepatitis B rates are lower among Canadian blood donors born in hepatitis B vaccine-eligible years, 2005 to 2020."

Renaud C, Bazin R, Grégoire Y, Germain M, Boivin A, Lewin A. "Can we do SARS-CoV-2 cumulative seroprevalence study in a vaccinated population? Anti-N seroprevalence study among blood donors in Québec."

Joint 35th European Immunogenetics and Histocompatibility Conference; Amsterdam, the Netherlands, May 17-20, 2022

Poster

Lemieux W, Richard L, Sapir-Pichadze R, Lewin A. "Understanding the stem cell transplant needs in the population of Québec using high-resolution HLA-A, -B, -C, -DPB1, -DQB1, and -DRB1 haplotype and allele frequencies."

Canadian Society for Transfusion Medicine (CSTM) annual conference; Toronto, Canada, May 26–29, 2022

Posters

Bazin R, Laumaea A, Lewin A, Chatterjee D, Simard C, Tremblay T, Rouleau P, Allard MÈ, Perreault J, Finzi A. "Response of lymphopenic plateletpheresis donors to COVID-19 vaccination."

Leiva-Torres GA, Baillargeon N, Savary-Bélanger S, Thomas N, Constanzo-Yanez J, Éthier C, Lavoie M, Laroche V, Ouellet P, Robitaille N, Latour C. "Anti-PP1Pk alloimmunization during pregnancy: A case study with a favorable outcome."

Renaud C, Cortes L, Beaudoin J, Thibeault C, Deschênes J, Tremblay S, Valiquette L, Germain M, Grégoire Y, Lewin A. "Impact of the SARS-CoV-2 pandemic on false positive rates for syphilis screening."

Renaud C, Domingue MP, Houle-Aubé É, Thibeault C, Deschênes J, Camirand-Lemyre F, Grégoire Y, Lewin A. "Characteristics of transgender blood donors in Québec and risk of vasovagal reactions."

Thibeault C, Deschênes, Renaud C, Germain M, Grégoire Y, Lewin A, Rabusseau I. "Adverse reactions amid a suspension of donor blood pressure measurement: a retrospective, observational study in Québec."

37th International Congress of the International Society of Blood Transfusion (ISBT); June 4–8, 2022 (virtual event)

Oral Presentations

Bazin R, Laumaea A, Lewin A, Chatterjee D, Simard C, Tremblay T, Rouleau P, Allard ME, Perreault J, Finzi A. "Response of lymphopenic apheresis platelet donors to COVID-19 vaccination."

Domingue MP, Camirand-Lemyre F, Aubé E, Renaud C, Thibeault C, Lewin A. "Risk of TRALI and HIV associated with donations from transgender donors in Québec, Canada."

Posters

Baillargeon N, Lavoie J, Perreault J, Constanzo-Yanez J, Éthier C, Rhéaume MÈ, Leiva-Torres GA. "Management of patients with a JK*01w.01 allele causing a weak JK(a)."

Leiva-Torres GA, Baillargeon N, Savary-Bélanger S, Thomas N, Constanzo-Yanez J, Éthier C, Lavoie M, Laroche V, Ouellet P, Robitaille N, Latour C. "Anti-PP1Pk alloimmunization during pregnancy: A case study with a favorable outcome."

2022 Cord Blood Connect: The International Congress for Cord Blood and Perinatal Tissue Research; South Beach, United States, September 9–11, 2022

Posters

Dumont N, Rouleau P, Margaillan G, Laganière J. "A Rapid and Sensitive IL-3-Based Assay Reveals How Various Pre-Processing Conditions Affect the Potency of Hematopoietic Stem Cells in Fresh Cord Blood Units."

Dumont-Lagacé M, Feghaly A, Thauvette G, Meunier MC, Lemieux W, Fournier D, Richard L, Lemieux S, Sauvageau G, Cohen S. "ECTmatch: optimizing small-scale cord blood banking through HLA analysis."

Lemieux W, Richard L, Fournier D, Joron S, Sapir-Pichadze R, Lewin A. "Comparative analysis of the cord blood bank in Québec."

29th International Congress of The Transplantation Society, Buenos Aires, Argentina, September 10–14, 2022 (hybrid event)

Oral Presentation

Lemieux W, Fleisher D, Yang YA, Nieman M, Lewin A, Sapir-Pichadze R. "Dissecting the impact of molecular T-cell HLA mismatches in kidney graft failure: a retrospective cohort study."

IPFA/PEI 28th International Workshop on Surveillance and Screening of Blood-borne Pathogens; Porto, Portugal, September 21–22, 2022

Guest Lectures

Germain M. "Serosurveillance of SARS-CoV-2 in Frequent Plasma Donors."

Germain M. "Cost-Effectiveness Study of Pathogen Reduction/Inactivation Technology in Quebec."

American Society for Histocompatibility and Immunogenetics (ASHI) 48th Annual Meeting, Las Vegas, United States, October 24–28, 2022

Posters

Lemieux W, Lewin A, Sapir-Pichadze, Richard L. "Addressing registry diversity for the population of Québec using high-resolution HLA-A, -B, -C, -DPB1, -DQB1, and -DRB1 haplotype and allele frequencies."

Lemieux W, Lewin A, Sapir-Pichadze R, Richard L, Fournier D, Joron S. "Comparison of the stem cell donor registry and cord blood bank in Québec."

2022 Virtual Meeting of the Association for the Advancement of Blood & Biotherapies (AABB); November 6–7, 2022 (virtual event)

Oral Presentation

Ramirez-Arcos S, Kumaran D, Asanger C, Bringmann P, Cloutier M, Gravemann U, Ketter P, Lu T, Niekerk T, Munoz B, Seltsam A, Süßner S, Vollmer T, McDonald CP. "Psychrotrophic bacteria proliferate in cold-stored platelet components."

Posters

Baillargeon N, Perreault J, Rhéaume MÈ, Trépanier P, Constanzo-Yanez J, Éthier C, Latour C, Leiva-Torres GA. "Management of sickle cell disease patients with rare RHCE variants altering the expression of the e (RH5) and hrB (RH31) antigens using the monocyte monolayer assay."

Blais-Normandin I, Éthier C, Baillargeon N, Latour C, Robitaille N. "Variations in serology testing in patients with warm autoimmune hemolytic anemia in the province of Québec, Canada."

Cayer MP, de Grandmont MJ, Bhakta V, Fournier MJ, Robitaille M, Sheffield W, Jacques A, Bazin R, Robitaille N, Germain M, Brouard D. "Fibrinogen in plasma and cryoprecipitate: a study to compare the performance of two detection methods."

Constanzo-Yanez J, Robert MH, Chevrier MC, Robitaille N. "Automated routine C,E,c,e and K testing on donors: a step toward new rare Rh blood identification."

Dubé C, Latour C, Constanzo-Yanez J, Robitaille N. "Safety and usage of autologous blood donation in pregnancy with rare blood."

Gagnon LL, Lacroix J, Popovsky MA, Lambert G, Robillard P, Robitaille N, Lord S, Vachon K, Drouin S, Rioux MP, Grenier J, Nawej KI, Lavoie M, Rioux-Masse B, Singbo MNU, Laroche V. "Risk factors of transfusion-associated circulatory overload (TACO): a case-control study from the Québec Hemovigilance System (QHS)."

Lampron MC, Loubaki L. "In vitro exposition of whole blood to a cannabinoid mixture impairs the quality of red blood cell and platelets."

Latour C, Gaussen A, Beaudoin J, Leiva-Torres GA, Rochette S, Robitaille N. "Incidence of acute hemolytic transfusion reaction among ABO-incompatible recipients transfused with A_3 blood: a case series." Awarded one of the best poster presentation.

Masse C, Grégoire Y, Sauvageau S, Rabusseau I, Gagnon M, Cayer MP, Jacques A, Brouard D. "Long-term outcomes associated with the optimization of apheresis platelet collection and supply."

Renaud C, Germain M, Lewin A, Gaussen A, Tremblay S, Valiquette L, Grégoire Y, Lafond C, Cortes L. "Impacts of systematically screening all blood donations for parvovirus B19 and hepatitis A using nucleic acid tests."

Renaud C, Lewin A, Grégoire Y, Boivin A, Perreault J, Fournier MJ, De Serres G, Germain M, Bazin R. "Use of anti-nucleocapsid serologic ratio in frequent plasma donors as a tool to identify SARS-CoV-2 infections during the Omicron wave."

Robert MH, Lewin A, Chevrier MC, Beaudoin J, Robitaille N. "Blood donor center introducing routine automated C,E,c,e and K phenotyping: impact on phenotyping activities of hospital laboratories."

Theiler CM, Hu ZG, Lomas-Francis C, Vege S, Chevrier MC, Éthier C, Leiva-Torres GA, Keller MA, Kaherl K, Johnson ST. "Weak and partial D phenotyping: a comparison study between molecular and serologic results."

Workshop

Reynolds C, Drews SJ, Lewin A. "Blood safety: epidemiological surveillance and risk assessment for emerging pathogens."

GenDx Webinar, November 23, 2022 (online webinar)

Guest Lecture

Lemieux W. "Population study of the province of Québec: Through the lens of the Registry."

64th American Society of Hematology (ASH) Annual Meeting and Exposition; New Orleans, LA, United States, December 10–13, 2022

Published Abstract

Boccacci Y, Margaillan G, Dumont N, Dubé P, Doyon Y, Laganière J. "Ex vivo CRISPR-based sickle cell modeling"

Patents granted in 2021-2022 and patent applications under examination

"Methods for culturing and/or differentiating hematopoietic stem cells into progenitors and uses thereof". Patents issued in Canada (CA2987974C), China (CN107922926B), Republic of Korea (KR10-2278306), Israel (IL256093), Japan (JP6954844), and New Zealand (NZ738216). Divisional patent application under examination in the United States (published under US2021023131A1). Laganière J, Dumont N, inventors. Héma-Québec, assignee. Patent expiry : 2036-06-03.

Internal reports

1. Boyer L, Brouard D. Comparaison des profils de refroidissement observés au niveau des dons de sang prélevés en dispositif T1 pendant le transport en boite Isotherme et en système thermorégulateur VIP (GÉO-111 [2020O]/33064). Final report presented to Luc Lévesque (Vice-présidence aux produits sanguins et lait maternel) on June 8, 2021.

2. Boyer L, Brouard D. Comparaison des propriétés d'isolation de la boite Isotherme avec celles de son format biodégradable de remplacement (GÉO-111 [2021E]/33064). Final report presented to Synthia Sauvageau (Vice-présidence aux produits sanguins et lait maternel) on November 25, 2021.

3. Boyer L, Brouard D. Évaluation d'un format de remplacement des sacs thermorégulateurs pour le transport des produits à température pièce (GÉO-111 [2019S]/33064). Final report presented to Cynthia Métellus (Vice-présidence qualité et développement) on April 23, 2021.

4. Boyer L, de Grandmont MJ, Brouard D. Évaluation des impacts d'une exposition à température pièce des sacs réfrigérants en chambre de conditionnement sur leurs propriétés réfrigérantes (GEO-111 [2021F]/33064). Final report presented to Sylvain Desjardins (Vice-présidence à la chaîne d'approvisionnement) on January 28, 2022.

5. Boyer L, Ducas E, de Grandmont MJ, Brouard D. Emballage VIP avec insert composé de polyéthylène pour le transport des prélèvements de sang total. Final report presented to Luc Lévesque (Vice-présidence aux produits sanguins et lait maternel) on June 21, 2021.

6. Boyer L, Ducas E, Girard M. Projet MT-2020-001 Accréditation FACT. Optimisation du procédé de cryopréservation des cellules souches périphériques (AMI-2101). Final report presented to Diane Fournier (Vice-présidence à la médecine transfusionnelle) on December 3, 2021.

7. Boyer L, Dussault N, Brouard D. Développement et optimisation d'un support métallique adapté au maintien des cassettes de cellules souches périphériques pendant le transport en cryotransporteur (GÉO-111/33064). Final report presented to Diane Fournier (Vice-présidence à la médecine transfusionnelle) on December 21, 2021.

8. Cayer MP, de Grandmont MJ, Fournier MJ, Brouard D. Analyse des écarts observés entre les quantités de fibrinogène dans les cryoprécipités distribués par Héma-Québec et la Société canadienne du sang (AMI-2108/33503). Final report presented to Marc Germain (Vice-présidence aux affaires médicales et à l'innovation) on February 7, 2022.

9. De Grandmont MJ, Laforce-Lavoie A, Brouard D. Caractérisation des performances du congélateur Thermo Fisher TSX5030FA (T = 30 °C) pour le traitement du plasma au centre Plasmavie de St-Bruno (AMI-2126/33543). Final report presented to Michel Gagnon (Vice-présidence aux produits sanguins et lait maternel) on December 16, 2021.

10. De Grandmont MJ, Laforce-Lavoie A, Nolin ME, Brouard D. Vigie des processus pour le prélèvement et traitement du plasma dédié au fractionnement. Final report presented to Marie-Pierre Fafard (Vice-présidence à la chaîne d'approvisionnement) on December 16, 2021.

11. Drouin M, Laganière J. Étude de faisabilité de l'extraction d'ADN circulant et du génotypage du RHD fœtal (ET-19-015). Final report presented on November 22, 2021.

12. Drouin M, Laganière J. Appréciation des trousses commerciales pour la détermination du RHD fœtal. Final report presented on February 2, 2022.

13. Ducas É, Landry P, de Grandmont MJ, Cloutier M. Effet d'un traitement à 35 °C sur les contaminants naturels de cornées entreposées dans l'Optisol-GS (GÉO-177/33345). Final report presented to Étienne Fissette (Vice-présidence aux affaires médicales et à l'innovation) on June 4, 2021.

14. Dumont N, Laganière J. Test fonctionnel des cellules souches hématopoïétiques par la réponse à l'IL-3 : valorisation de l'utilisation sur sang frais et impact des processus de mise en banque. Final report presented on June 21, 2022.

15. Dumont N, Masse C, Renée Bazin. Impact d'une purge sur la quantité de cellules extraites des cônes de leucoréduction lors de la collecte de plaquettes par aphérèse (AMI-2217). Final report presented to Michel Gagnon (Vice-présidence aux produits sanguins et lait maternel) on September 12, 2022.

16. Dussault N. Détermination des tares des dispositifs Trima v7.0 (82416 et 82616) pour la validation et la SPE-0113 (AMI-2106/33502). Final report presented to Pascale Riverin (Vice-présidence aux produits sanguins et lait maternel) on July 5, 2021.

17. Dussault N, Boyer L, de Grandmont MJ, Brouard D. Caractérisation des performances des systèmes thermorégulateurs utilisés par les centres hospitaliers pour le transport des produits sanguins (33544/AMI-2133). Final report presented to Marie-Hélène Robert (Vice-présidence à la médecine transfusionnelle) on January 26, 2022.

18. Dussault N, Cayer MP, Nolin ME, de Grandmont MJ, Brouard D. Quelle est la durée maximale acceptable de l'étape de pasteurisation du lait maternel? (GÉO-111/2020K). Final report presented to Pierre Noël (Vice-présidence aux produits sanguins et lait maternel) on April 23, 2021.

19. Dussault N, Cloutier M. Évaluation d'un support pour la congélation des allogreffes cutanées (GÉO-111/2020P/33064). Final report presented to Étienne Fissette (Vice-présidence aux affaires médicales et à l'innovation) on June 2, 2021.

20. Dussault N, de Grandmont MJ, Boyer L, Allard ME, Cayer MP, Brouard D. Migration du logiciel de contrôle et du paramétrage de l'appareil de prélèvement par aphérèse (TRIMA v7.0) (AMI-2106/33502) Évaluation de performance et impacts opérationnels. Final report presented to Michel Gagnon (Vice-présidence aux produits sanguins et lait maternel) on September 29, 2021.

21. Dussault N, Landry P, Boyer L, de Grandmont MJ, Girard M. Évaluation de la technologie NovaSterilis pour le développement d'une méthode de nettoyage et de stérilisation des tissus musculosquelettiques – Phase 2 : les tendons (GEO-163/33220). Final report presented to Étienne Fissette (Vice-présidence aux affaires médicales et à l'innovation) on July 26, 2022.

22. Fonseca S, Cayer MP, Girard M. Propositions pour le remplacement de l'analyseur hématologique Ac•T™ 5diff CP dédié aux analyses pré-don des procédures de prélèvements de granulocytes par aphérèse (GÉO-111 [2019O]/33064). Final report presented to Michel Gagnon (Vice-présidence aux produits sanguins et lait maternel) on September 2, 2021.

23. Girard M. Revue de littérature rapide sur des composés alternatifs au gluconate de chlorhexidine et à la povidone iodée pour la désinfection cutanée pré-ponction (GÉO-111 [2021B]/33064). Final report presented to Claudia Bédard (Vice-présidence aux produits sanguins et lait maternel) on June 22, 2021.

24. Girard M. Vigie Pasteurisation Aperçu des appareils disponibles sur le marché et des alternatives possibles à la pasteurisation Holder. Final report presented to Pierre Noël (Vice-présidence aux produits sanguins et lait maternel) on July 6, 2021.

25. Laforce-Lavoie A, Fournier MJ, Girard M. Mise au point d'une méthode de détection des champignons filamenteux dans les unités de sang de cordon (AMI-2114/33521). Final report presented to Diane Fournier (Vice-présidence à la médecine transfusionnelle) on May 25, 2022.

26. Laforce-Lavoie A, Nolin MÈ, Fournier MJ, de Grandmont MJ, Brouard D. Nouvelles stratégies pour le prélèvement de plasma de fractionnement (GÉO-170 Phase II/33305). Final report presented to Luc Lévesque (Vice-présidence aux produits sanguins et lait maternel) on April 7, 2021.

27. Landry P, de Grandmont MJ, Brouard D. Solutions alternatives à l'emballage d'hiver pour le transport de tubes d'échantillonnage (GEO-111 [2022A]/33064). Final report presented to Leila Snouber (Vice-présidence à la chaîne d'approvisionnement) on February 10, 2022.

28. Landry P, Dussault N, Boyer L, de Grandmont MJ, Girard M. Évaluation de la technologie NovaSterilis pour le développement d'une méthode de nettoyage et de stérilisation des tissus musculosquelettiques Phase 1 : les os spongieux (GEO-163/33220). Final report presented to Étienne Fissette (Vice-présidence aux affaires médicales et à l'innovation) on April 19, 2022.

29. Landry P, Allard ME, Robidoux J, Brouard D, de Grandmont MJ. Évaluation de performance de l'hémoglobinomètre CompoLab distribué par Fresenius Kabi dans le cadre du processus d'AO 202101AO-210 (AMI-2116/33523). Final report presented to Michel Gagnon (Vice-présidence aux produits sanguins et lait maternel) on September 10, 2021.

30. Robidoux J, Brouard D, de Grandmont MJ. Évaluation du risque associé au retrait du volume d'air résiduel présent au niveau de la poche de plasma pour le donneur au terme du prélèvement par plasmaphérèse en appareil PCS2 (AMI-2121/33542). Final report presented to Isabelle Rabusseau (Vice-présidence aux affaires médicales et à l'innovation) on November 25, 2021.

31. Robidoux J, Landry P, Brouard D, de Grandmont MJ. Un guide d'inspection visuelle pour identifier la présence d'hémoglobine libre dans le plasma et un débordement en globules rouges pendant le processus de prélèvement du plasma de fractionnement par PCS2 (AMI-2113/33520). Final report presented to Isabelle Rabusseau (Vice-présidence aux affaires médicales et à l'innovation) on May 21, 2021.

Training

Since its founding, Héma-Québec has contributed to training the next generation of specialists in basic and applied research in fields that are relevant to its activities. Our organization also regularly welcomes clinicians who wish to acquire a specialization in transfusion medicine. Beyond specialized training, Héma-Québec offers internships for college and university students, thereby providing an opportunity to acquire practical experience to meet the requirements of their study program.

In 2021-2022, the scientific staff of the Vice-présidence aux affaires médicales et à l'innovation codirected the work of five master's students and one doctoral student. Five interns pursued a post-doctoral internship in Medical Affairs and Innovation during the same period. Five undergraduate students enrolled at Université Laval completed an internship in the research laboratories of our Québec facility in 2021 and 2022. Finally, the Vice-présidence à la médecine transfusionnelle welcomed three Fellows who came to take part in training internships in transfusion medicine.

Academic path and training of students and interns in the life sciences

University graduates in the life sciences can pursue their graduate studies at Héma-Québec while benefiting from the mentoring of a supervisor in the university setting. These students are often recipients of scholarships from funding agencies based on the excellence of their academic record, especially the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canadian Institutes of Health Research (CIHR), the Fonds de recherche du Québec – Santé (FRQS), the Fonds de recherche du Québec – Nature et technologies (FRQNT), and Mitacs.

These scientists have varied backgrounds, some specializing in microbiology, biochemistry, bioinformatics, public health, epidemiology, mathematics or statistics. This interdisciplinarity offers students a rich and rewarding experience.

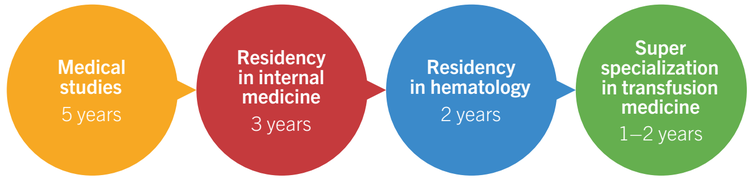
Academic path of students in the life sciences

Their work helps Héma-Québec fulfill its basic mission and innovation objectives.

Academic path and training of medical fellows at Héma-Québec

Medical fellows at Héma-Québec are specialists in hematology, pathology or anesthesia who undertake one to two years of post-specialization training in transfusion medicine. They receive a grant to complete their training and academic path prior to specialization.

Academic path of medical fellows



Currently, four super specialization programs are accredited by the Royal College of Physicians and Surgeons of Canada (RCPSC): those of the University of Toronto (Toronto), McMaster University (Hamilton), the University of British Columbia (Vancouver), and Dalhousie University (Halifax). Since none of these universities are located in Québec, fellows must complete their training at one of the universities mentioned above. Héma-Québec's fellows follow a minimum of four months of mandatory training with a supplier of blood products at Héma-Québec, rather than at Canadian Blood Services.

During their training at Héma-Québec, fellows spend two months at the Montréal facility where they are exposed to the operational activities of our various product lines, donor recruitment activities, our quality management system, and the services offered by the Reference Laboratories, Qualification Laboratories and Stem Cell Registry. As part of their two-month training at the Québec facility, fellows mostly focus on studying complex cases analyzed by the Québec Reference Laboratory. They also have the opportunity to share ideas with the Human Tissues and Research teams. Fellows have specific training objectives to meet; accordingly, they regularly refer to Héma-Québec employees for answers to highly specific and important questions. Fellows are also deeply involved in research and take part in several projects in collaboration with Héma-Québec.

Contribution of Héma-Québec's scientific staff to training activities and continuing education workshops

In addition to training initiatives for its own staff, Héma-Québec contributes to maintaining the highest quality standards by producing educational material for its hospital partners. For several years, Héma-Québec has offered training in immunohematology (both theoretical and practical) to laboratory technicians working in hospital blood banks in Québec and elsewhere in the world (Web educational platform). The aim of this training, offered in three languages (French, English and Spanish), is to enable technicians to acquire the methodology and techniques needed to solve immunological problems encountered on a daily basis in a blood bank laboratory, as well as problems encountered during serological studies in patients suffering from autoimmune hemolytic anemia (see the website for more details). This past year, 238 registrations were recorded for this training. The year 2022 marked the resumption of the practical training sessions, with 18 persons participating.

Héma-Québec also provides regulatory training aimed at ensuring that the staff that collects cord blood in partner hospitals are properly trained and qualified. In the past year, 147 registrations of physicians and nurses were recorded for this training.

Héma-Québec researchers also teach university courses to scientists and clinicians in training. Some teach sessions in molecular medicine and immunology courses, which are offered to Master's and PhD students and postgraduate interns in the neurosciences, molecular medicine, microbiology-immunology, and the pharmaceutical sciences. Other researchers participate in a course on stem cell transplantation. Clinicians working in our organization also provide training in sickle cell anemia, neonatal anemia and apheresis. An expert in statistics and epidemiology also teaches a course in biostatistics.

Research partners

Héma-Québec is privileged to be able to count on the expertise of its many partners who collaborate on several of its research activities. We would especially like to thank the partners listed below for their close collaborations in 2021-2022.

Affinité Instruments

Affinité Instruments is a pioneer in the development and marketing of new technologies that use surface plasmon resonance (SPR). In the past year, Héma-Québec collaborated with this company to develop and characterize the performance of an SPR technology that detects antibodies directed against SARS-CoV-2 (page 7).

Public Health Agency of Canada (PHAC)

PHAC promotes and protects the health of Canadians through leadership, partnership, innovation and action in public health. This agency was a key partner in the establishment of a biobank of samples from frequent plasma donors (PlasCoV, page 6) and in a study on the risk of babesiosis in Canada (page 12).

Biomedical Excellence for Safer Transfusion (BEST) Collaborative

The BEST Collaborative is an international consortium of blood product suppliers and university and industrial experts who document and formulate recommendations on the procedures to follow to improve operational and clinical practices in transfusion medicine and cell therapy. In 2021-2022, Héma-Québec collaborated with the BEST in a study on persons who were deferred from donating blood due to a recent tattoo or piercing (page 13), and in a study that aimed to better understand the variations in fibrinogen content in cryoprecipitates (page 18).

Centre de recherche du Centre hospitalier de l'Université de Montréal (CRCHUM)

The CRCHUM is a research hub that brings together experienced scientists from various fields involved in the improvement of health. The CRCHUM covers a broad spectrum of activities, from basic research to clinical research. In the past year, the CRCHUM has been a major partner in the conduct of projects on SARS-CoV-2 humoral immunity (pages 7 and 8).

Centre hospitalier de l'Université Laval

In addition to providing specialized and ultra-specialized care to thousands of patients, this institution is home to international calibre researchers. These researchers collaborated with Héma-Québec on developing and characterizing the performance of an SPR technology for detecting antibodies directed against SARS-CoV-2 (page 7).

COVID-19 Immunity Task Force (CITF)

The CITF is a working group formed in response to COVID-19, which brings together clinical experts whose mandate is to determine the extent of SARS-CoV-2 infection in Canada, understand the nature of immunity following SARS-CoV-2 infection, develop improved antibody testing methods and monitor scientific developments in vaccines. Héma-Québec collaborated closely with the CITF to establish the PlasCoV biobank (page 6).

Montreal Heart Institute (MHI)

This ultra-specialized cardiology hospital treats patients with heart disease, trains the specialists of tomorrow, and devotes considerable resources to prevention and cardiology research. Héma-Québec is privileged to have collaborated with the MHI as part of a project that aimed to determine the characteristics of convalescent plasma to be considered to limit the inflammation-induced malfunction of lymphatic endothelial cells (LEC) (page 9).

Institut national de santé publique du Québec (INSPQ) and the ministère de la Santé et des Services sociaux (MSSS)

The INSPQ is a centre of public health expertise. Its mission is to advance knowledge and formulate strategies aiming to improve the health and well-being of Quebecers. The MSSS provides health and social services to Quebecers to improve the health and well-being of its citizens. In response to the COVID-19 pandemic, Héma-Québec conducted a seroprevalence study to inform the INSPQ and the MSSS about the seroprevalence of anti-SARS-CoV-2 in the Québec population (page 6). Héma-Québec also collaborated with the MSSS to identify needs and prepare specifications leading to the acquisition and, subsequently, the evaluation of the performance of new thermoregulation systems adapted for the transport of blood products in hospitals (page 21).

Sanquin

This nonprofit organization supplies blood products to the Netherlands and is also a leader in transfusion medicine research. Héma-Québec is privileged to have participated in a study conducted by Sanquin and Canadian Blood Services on persons ineligible for blood donation because of a recent tattoo or piercing (page 13).

Canadian Blood Services (CBS)

CBS is the Canadian counterpart of Héma-Québec and the main supplier of blood products, cells and tissues outside of Québec. Héma-Québec has been collaborating with the CBS for many years, and 2021-2022 was no exception, with the conduct of a study to evaluate the risk of transmission of babesiosis through blood transfusion (page 12), a study on persons who were deferred from donating blood due to a recent tattoo or piercing (page 13), and a study that aimed to compare methods to prepare and analyze cryoprecipitates (page 18).

Université de Montréal (UdeM)

UdeM is one of the leading academic institutions in Canada and the world, known especially for its research activities. Héma-Québec was privileged to be able to count on the many collaborators affiliated with this institution to develop and characterize the performance of an SPR technology that detects antibodies directed against SARS-CoV-2 (page 7).

Yale University

This American institution is a world leader in research and development. The expertise of this university's researchers has been essential for studying the effector functions of antibodies to SARS-CoV-2 in a murine model (page 7).

External funding

Research grants have been awarded to many researchers for projects to which Héma-Québec has contributed.

$2,492,000

Research grant awarded to a group of Canadian researchers — which included Dr. Deepali Kumar (lead investigator) and Mélanie Dieudé (principal investigator) — by the ministère de l'Économie et de l'Innovation du Québec, the Fondation du CHUM, the Canadian Institutes of Health Research (CIHR), the Canada Foundation for Innovation (CFI), the Canadian Donation and Transplantation Research Program (CDTRP), the Sentinelle COVID Québec network led by the Laboratoire de santé publique du Québec (LSPQ) in collaboration with the Fonds de recherche du Québec – Santé, valid from March 2021 to March 2023.

$995,000

Research grant awarded by the Canadian Institutes of Health Research (CIHR) to Dr. Paul R. Fortin from the Centre de recherche du CHU de Québec – Université Laval (principal investigator), Dr. Gaston De Serres from the Institut national de santé publique du Québec (principal investigator), Dr. Ines Colmegna from the Division of Experimental Medicine at McGill University (principal investigator), Renée Bazin (co-investigator), and Mélanie Dieudé (co-investigator), valid from December 2021 to March 2024.

$277,000

Research grant awarded by the Canadian Institutes of Health Research (CIHR) to Dr. Nathalie Auger from the Centre de recherche du CHUM and Sylvie Martel from the Institut national de santé publique du Québec (principal investigators), and Antoine Lewin (co-investigator), valid from February 2022 to January 2024.

$157,000

Research grant awarded by the Heart and Stroke Foundation of Canada to Dr. Nathalie Auger from the Centre de recherche du CHUM (principal investigator) and Antoine Lewin (co-investigator), valid from July 2022 to July 2025.

$120,000

Mitacs-Accelerate grant awarded to a post-doctoral fellow supervised by Dr. Andrés Finzi from the Centre de recherche du CHUM (main supervisor) and Renée Bazin (industrial supervisor), valid from May 2020 to April 2022.

$95,000

Research grant awarded by the Public Health Agency of Canada (PHAC) — COVID-19 Immunity Task Force (CITF) to Dr. Andrés Finzi from the Centre de recherche du CHUM (principal investigator), Renée Bazin (co-investigator), and Dr. Marc Germain (co-investigator), valid from September 2022 to March 2023.

$50,000

Research grant awarded by ThéCell, Réseau de thérapie cellulaire, tissulaire et génique du Québec to Professor Maria Fernandes from the Centre de recherche du CHU de Québec – Université Laval (principal investigator), Renée Bazin (co-investigator), and Mélissa Girard (co-investigator), valid from April 2021 to March 2022.

$40,000

Mitacs-Accelerate grant awarded to a Master's student supervised by Professor Jean-François Masson from the Université de Montréal (main supervisor) and Danny Brouard (industrial supervisor), valid from September 2022 to August 2023.

$30,000

Mitacs-Accelerate grant awarded to a Master's student supervised by Professor Maria Fernandes from the Centre de recherche du CHU de Québec – Université Laval (main supervisor) and Mélissa Girard (industrial supervisor), valid from September 2021 to August 2023.

$17,500

Scholarship awarded by the National Sciences and Engineering Research Council of Canada (NSERC) to a Master's student supervised by Professor Felix Camirand-Lemyre from the Université de Sherbrooke (main supervisor) and Antoine Lewin (industrial supervisor), valid from May 2022 to April 2023.

Organizational structure

Scientific activity revolves around two vice-presidencies, nine divisions and one research unit.

Vice-présidence aux affaires médicales et à l'innovation
Dr. Marc Germain

- **Direction médicale, microbiologie et épidémiologie** — Dr. Christian Renaud
- **Direction scientifique** — Renée Bazin
- **Direction des services infirmiers** — Isabelle Rabusseau
- **Direction de l'exploitation des tissus humains** — Étienne Fissette
- **Direction des opérations de recherche** — Mélanie Dieudé
- **Unité d'épidémiologie, vigie et gestion des risques biologiques** — Antoine Lewin

Vice-présidence à la médecine transfusionnelle
Dr. Nancy Robitaille

- **Direction médicale, hématologie et cellules souches** — Dr. Catherine Latour
- **Direction des cellules souches** — Diane Fournier
- **Direction des laboratoires de référence** — Marie-Claire Chevrier
- **Direction au partenariat clinique avec les centres hospitaliers** — Marie-Hélène Robert

Vice-présidence aux affaires médicales et à l'innovation, Dr. Marc Germain

Provides medical, scientific and nursing expertise, as well as monitoring activities to offer services and safe biological products of human origin, integrating the most recent technological advances while ensuring the development and production of human tissues.

- Direction médicale — microbiologie et épidémiologie (Dr. Christian Renaud)
  - > Follows up presumed cases of transfusion-transmitted infections
- Direction de l'exploitation des tissus humains (Étienne Fissette)
  - > Is responsible for harvesting, processing, qualifying, storing and distributing human tissues
  - > Collaborates with the Direction des opérations de recherche in developing new products and procedures for processing human tissues
- Direction scientifique (Renée Bazin)
  - > Supervises and supports all the scientific activities within the vice-présidence aux affaires médicales et innovation
- Direction des opérations de recherche (Mélanie Dieudé)
  - > Conducts research projects and the development of new products in the organization's five areas of activity
  - > Develop products and optimizes product qualification tests
  - > Supports scientific and technical activities related to Héma-Québec's five sectors of activity
  - > Evaluates technologies as part of call for tenders' processes
  - > Provides scientific support on technical or operational problems
  - > Works to optimize procedures and logistics in support of continuous improvement of operations
- Unité d'épidémiologie, vigie et gestion des risques biologiques (Antoine Lewin)
  - > Conducts epidemiological research projects
  - > Is responsible for the strategic monitoring of Héma-Québec's sectors of activity
  - > Provides expertise in risk management related to the biological products prepared by Héma-Québec
  - > Provides scientific, biostatics and methodology support to the design, management, drafting, analysis and publication of scientific articles and research protocols
- Direction des services infirmiers (Isabelle Rabusseau)
  - > Ensures that the collection of blood components is done under optimal conditions for the well-being of donors, using the most recent standards and knowledge applicable to all the techniques used
  - > Is responsible for inquiries regarding adverse reactions occurring during blood collection
  - > Answers questions from donors, including about blood donations and the types of collections

Vice-présidence à la médecine transfusionnelle, Dr. Nancy Robitaille

Provides tests, services and specialized transfusion medicine and stem cell transplant products to help hospitals and our international partners provide the care needed by their patients in due time, and participates in the production of educational materials related to transfusion medicine (e.g., Transfusion Camp in Toronto).

- Direction médicale hématologie et cellules souches (Dr. Catherine Latour)
  - > Supervises transfusion medicine Fellows and hematology residents
  - > Provides medical expertise in hematology and cell therapy
  - > Takes part in the donor selection criteria committee (including the joint committee with Canadian Blood Services)
  - > Participates in evaluating reported transfusion reactions and donors presenting with health problems not listed in the selection criteria
  - > Helps manage rare blood cases by providing expertise in immunohematology and platelet immunology
- Direction des cellules souches (Diane Fournier)
  - > Monitors the collection, preservation and maintenance of the stem cell bank
  - > Documents the genetic and molecular parameters influencing compatibility between stem cell donors and recipients in a registry accessible worldwide
- Direction des laboratoires de référence (Marie-Claire Chevrier)
  - > Conducts specialized immunohematology, platelet and HLA immunology tests for hospital blood banks
  - > Maintains an inventory of phenotyped packed red blood cells
  - > Performs HLA tests for the Stem Cell Donor Registry, the Public Cord Blood Bank and the registry of platelets with HLA compatible profiles
  - > Selects specialized blood products that are compatible with patients
  - > Is responsible for the rare blood program
- Direction au partenariat clinique avec les centres hospitaliers (Marie-Hélène Robert)
  - > Strengthens Héma-Québec's role as a partner
  - > Develops a personalized client-centred approach based on their needs
  - > Makes the hospitals' point of view known regarding all projects

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