BMJ Open

Cohort Profile: The Management of Post-transplant Infections in Collaborating Hospitals (MATCH) Program - A prospective cohort of all transplant recipients at Copenhagen University Hospital – Rigshospitalet, Denmark

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-089966
Article Type:	Cohort profile
Date Submitted by the Author:	13-Jun-2024
Complete List of Authors:	Esmann, Frederik; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP), Rigshospitalet Zahid, Sadaf; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Moestrup, Kasper ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Normand, Nick; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Matthews, Charlotte; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Gustafsson, Finn; Rigshospitalet, Department of Cardiology; University of Copenhagen, Department of Clinical Medicine Sengeløv, Henrik; Rigshospitalet, Department of Hematology; University of Copenhagen Faculty of Health and Medical Sciences Perch, Michael; Rigshospitalet, Department of Cardiology; University of Copenhagen, Department of Clinical Medicine Schultz, Nicolai ; Rigshospitalet, Department of Surgical Gastroenterology and Transplantation Sørensen, Søren; University of Copenhagen, Department of Clinical Medicine; Rigshospitalet, Department of Nephrology Hansen, Jesper; Herlev Hospital, Department of Nephrology Christensen, Vibeke ; Rigshospitalet, Department of Pediatrics and Adolescent Medicine Murray, Daniel ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Lundgren, J; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP); University of Copenhagen Faculty of Health and Medical Sciences Crone, Cornelia ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Helleberg, Marie; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP); Rigshospitalet, Department of Infectious Diseases
Keywords:	TRANSPLANT MEDICINE, INFECTIOUS DISEASES, Bone marrow transplantation < HAEMATOLOGY, EPIDEMIOLOGY, IMMUNOLOGY, VIROLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Cohort Profile: The Management of Post-transplant Infections in Collaborating Hospitals (MATCH) Program

- A prospective cohort of all transplant recipients at Copenhagen University Hospital – Rigshospitalet, Denmark

Frederik V. L. Esmann[1], Sadaf Zahid[1], Kasper Sommerlund Moestrup[1], Nick Normand[1], Charlotte Matthews[1], Finn Gustavsson[2 5], Henrik Sengeløv[3 4], Michael Perch[2 5], Nicolai Aagaard Schultz[6], Søren Schwartz Sørensen[5 7], Jesper Melchior Hansen[8], Vibeke Brix Christensen[9], Daniel D. Murray[1], Jens Lundgren[1 4], Cornelia Geisler Crone[1], Marie Helleberg[1 4 10]

[1]Centre of Excellence for Health, Immunity and Infections (CHIP), Rigshospitalet, [2] Department of Cardiology, Rigshospitalet University Hospital, Copenhagen, Denmark, [3] Department of Hematology, Rigshospitalet, Copenhagen, Denmark, [4] Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark, [5] Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark, [6] Department of Surgical Gastroenterology and Transplantation, Rigshospitalet, University of Copenhagen, 2100, Blegdamsvej, Denmark, [7] Department of Nephrology, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark, [8] Department of Nephrology, Copenhagen University Hospital, Herlev Hospital, Copenhagen, Denmark. [9] Department of Pediatrics and Adolescent Medicine, Rigshospitalet, Denmark, [10] Department of Infectious Diseases, Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark.

Abstract

Purpose The MATCH program, initiated in 2011 and still ongoing, was created to: 1) optimize the implementation of existing preventive strategies against viral infections in solid organ transplant (SOT) recipients and allogenic hematopoietic stem-cell transplant (HSCT) recipients, and 2) advance research in the field of transplantation by collecting data from a multitude of sources.

Participants All SOT and HSCT recipients at Copenhagen University Hospital, Rigshospitalet, are followed in MATCH. By February 2021, a total of 1192 HSCT recipients and 2039 SOT recipients have been included. Participants are followed life-long. An automated electronic data capture system retrieves prospective data from nationwide registries. Data from the years prior to transplantation are also collected.

Findings to Date Data entries before and after transplantation include: Biochemistry: 13,995,222 and 26,127,817; Microbiology, cultures: 242,023 and 410,558; Other microbiological analyses: 265,007 and 566,402; and Pathology: 170,884 and 200,394. There are genomic data on 2,431 transplant recipients, whole blood biobank samples from 1,003 transplant recipients and faeces biobank samples from 207 HSCT recipients. Clinical data collected in MATCH has contributed to 50 scientific papers published in peer-reviewed journals and has demonstrated success in reducing CMV-disease in SOT recipients. The program has established international collaborations with the Swiss Transplant Cohort Study and the lung transplant cohort at Toronto General Hospital.

Future Plans Enrolment into MATCH is ongoing with no planned end date for enrolment or follow-up. MATCH will continue to provide high quality data on transplant recipients and expand and strengthen international collaborations.

Word Count: 244

Strengths and limitations of this study

1. MATCH is an unselected prospective cohort with complete enrolment, encompassing all transplant recipients at Rigshospitalet, Copenhagen University Hospital, Denmark.
2. All patients followed in MATCH have a civil registration number, and linkage to the Danish civil registration system ensures almost complete life-long follow-up despite patients being transferred to other centres in Denmark.
3. The Danish civil registration system allows for linkage to multiple nationwide registries containing data on e.g. biochemistry, pathology, microbiology, imaging, prescriptions and hospital contacts, including ICD-codes for diagnoses and procedures, both from the period before and after transplantation.
4. MATCH patients, who have given consent to sampling, have provided whole blood samples, plasma samples, bronchoalveolar lavage and faeces samples to an extensive biobank.
5. MATCH enrols patients from a single centre, reducing the generalizability of findings.

Introduction

The first transplantation worldwide was performed in 1954 and the first in Denmark in 1964.[1,2] The field has developed significantly since then with better surgical technique, better understanding of transplant immunology, the development of immunotherapy, and several other advances in the field of medicine. In spite of these advances, transplantations are still associated with reduced life expectancy, with cancer, allograft rejection, and infectious complications being the most important causes. [3]

Transplant procedures remain relatively rare, underscoring the importance of systematical gathering of knowledge from expansive groups or cohorts. Many aspects in the field of transplantation, including prevention of infectious disease, lack consensus on best practices due to a paucity of strong evidence. [4–6] Therefore, the Management of Post-transplant Infections in Collaborating Hospitals (MATCH) program was developed at the Copenhagen University Hospital – Rigshospitalet, Denmark.

The prospective MATCH program was initiated in 2011. It was created for two main reasons: firstly, to optimize the implementation of existing preventive strategies against viral infections in solid organ transplant (SOT) recipients and hematopoietic stem-cell transplant (HSCT) recipients,

and secondly, to advance research in the field of transplantation by creating an overarching database collecting data from a multitude of data sources. The clinical part of MATCH seeks to improve outcomes of SOT patients, and has succeeded in reducing cytomegalovirus (CMV) disease by among other things implementing an electronic clinical support tool ensuring critical follow-up on both screening samples taken and not taken. [3] The MATCH cohort has been the basis of more than 50 publications published in peer-review journals so far.

This article aims to describe the profile of the MATCH cohort and provide transparency on its organization and the data available and thereby nurture further research and enhance collaborations.

Cohort Description

MATCH Organization

MATCH is anchored in the Centre of Excellence in Health, Immunity, and Infection (CHIP), at Copenhagen University Hospital – Rigshospitalet, Denmark. MATCH is led by a steering committee with two chairmen, a representative from each transplant department, a representative for the paediatric transplant recipients, and two representatives from the Centre of Excellence in Health, Immunity, and Infection (CHIP). The steering committee acts as a governing body, overseeing scientific and clinical operations in MATCH.

All transplant recipients from Rigshospitalet are systematically enrolled in MATCH when donor and recipients are matched. This includes all patients receiving a lung and/or liver transplantation in Denmark and all recipients of HSCT, kidney and heart transplantation from Eastern Denmark. Patients have been enrolled prospectively from 2011. Additionally, all transplant recipients from January 2004 until 2010 at the MATCH-departments have been added retrospectively to the MATCH program.

Data Infrastructure

The MATCH database is operated by CHIP and embedded into the data structure of PERSIMUNE (Centre of Excellence for Personalised Medicine of Infectious Complications in Immune Deficiency. CHIP is responsible for overall operation, data processing, stability, and access control of the MATCH database.

The PERSIMUNE Datawarehouse (DWH) receives data on patients in the MATCH cohort from a multitude of sources (Figure 1). This is enabled by the Danish civil registration system (CRS). [7]

Every Danish resident is registered in the CRS with a unique ten-digit Civil Personal Register (CPR) number. The CPR-number is used in all Danish registers and thereby allows linkage of data across multiple sources. Denmark has multiple national health registers, linked by the CPR-number. Provided that the relevant approvals have been obtained from the research legal department data specific for individual research projects can be imported into the DWH and thereafter linked with other data already available in the DWH in a pseudonymized combined data extract. An example is the import of data on consecutive pulmonary lung function tests on lung transplant recipients for a specific lung transplant project.

Data sources

DWH receive data from many of the national health registers, including The National Patient Register, The National Organ Donor Database, The Danish Hospital Medication Register, The Danish Microbiology Database (MiBa), The Danish Pathology Register, and The Cause of Death Register. More specifically, DWH receive data on investigations performed as part of clinical practice from: LABKA I (2005-2009) and LABKA II (2009-) provides data on biochemistry, MEDCOM (2004-) provides data on microbiology, pathology, and additional biochemistry. Data on medication and all outpatient prescriptions is provided by EPM1 (2005-2020), EPM3 (2012-2016) and Sundheds-databanken provides data on hospital contacts and -procedures and diagnosis codes. Data on demographics, deaths and emigration are obtained from the CRS and The Cause of Death Register (2010-). MADS (2005-), a local database, provides additional microbiology data. RIS/PACS (2005-) is a local data source that provide data on imaging. The DWH obtain clinical data from electronic medical files and genetic data from other internal sources.

Quality assurance

Before being incorporated into the data stream, data from each data source is checked by a five-step procedure, involving source identification, obtaining documentation, clarification of which data columns/types to collect, establishment of data harvest, and finally an assessment of the data harvest. An ongoing data cleaning and quality assurance (QA) process is performed. This process includes, but is not limited to, generating QA-tables, generating histograms for analysis, triangulation/cross validation of data, defining rules for clean-up, testing and validating clean-up rules, defining rules for monitoring data, and implementing monitoring rules and surveillance. Furthermore, clinical biochemistry and microbiology data are grouped according to sample material and type of analysis.

Data Enrichment

After import and cleaning of data in the DWH, PERSIMUNE performs additional data enrichment, combining data variables from data sources to create calculated variables based on standardized definitions. An example is the calculation of a Charlson comorbidity index (CCI). [8] Another example is a CMV infection algorithm used to define if a transplant recipient has a CMV infection. The algorithm checks if a recipient has two consecutive plasma CMV PCR taken within 14 days of each other with a viral load ≥ 273 IU/mL or one sample with a viral load ≥ 2730 IU/mL.

Clinical data

In overall numbers until February 28th 2021, the following data are available from the MATCH cohort: 464,783 medical diagnosis codes, 314,961 data entries on medication before recipient transplantation and 367,839 after transplantation. Biochemistry data is available with 13,995,222 entries before transplantation and 26,127,817 after. Microbiology data is available with 242,023 culture results before transplantation and 410,558 after, and data on other microbiology analysis performed is available with 265,007 results before transplantation and 566,402 after. Data on pathological examinations is available on 170,884 samples before and 200,394 after transplantation.

Some research projects result in additional data being incorporated into the DWH and is available for other research projects upon approval. One such example is the Classification of death causes after transplantation (CLASS) project. [9] CLASS is a methodology used to systematically and reliably determine and classify an accurate cause of death in all transplant recipients, than otherwise obtainable from Danish causes of death register.

Genetic Data

In 2017, after ethical approval samples from all patients in the MATCH cohort, with available material for analysis at that time point, were genotyped using the Infinium ® Global Screening Array-24 v1.0 from DeCode. In 2019, all patients in the MATCH cohort with available material for analysis were genotyped at 770558 SNP loci using a custom array from Affymetrix, designed to enrich for genes relating to immune dysfunction. In total, 2431 (75.2 %) transplant recipients have been genotyped.

Biobank

In 2015, a biobank for future research was established by PERSIMUNE, in collaboration with Rigshospitalet and the Department of clinical immunology, with samples being continuously collected from patients in the MATCH cohort (amongst others) that gave their consent. A total of 1731 patients have provided samples into the biobank. Blood samples are collected before transplantation and 1 year after transplantation, with 1207 (69.7 %) recipients having contributed at least one whole blood sample. In 2016, faeces samples were added to the collection scheme for two transplant recipient groups: HSCT and kidney transplant recipients with living donors. For HSCT recipients who have consented to this, faeces samples are collected pre-transplantation and at days 7, 14, 21, 28, and 180 after transplantation. For kidney transplant recipient, faeces samples are collected pre-transplantation, within 3 months and 3 months after transplantation. Since 2021, bronchoalveolar lavage fluid is collected and stored upon every bronchoscopy performed in lung transplant recipients who have consented to this.

Cohort participants

From 2011 until February 28th 2021, 3231 transplant recipients have been enrolled prospectively in the MATCH program with the majority being HSCT or kidney transplant recipients (Figure 2a). The number of patients enrolled has been stable over time, with a slight upwards trend (Figure 2b)

Among the 3231 transplant recipients, 4.3% had a re-transplantation. Overall, 59.6 % of transplant recipients were male. Age at transplantation was similar across the transplant groups with a mean age of 50 (IQR 35, 60). The proportion of transplant recipients under the age of 18 years, was 19.8 %, 12.5 %, 10.6 %, 4.3% and 0.6% for HSCT, liver-, heart-, kidney and lung recipients, respectively. The donor/recipient CMV and EBV serostatus in the cohort at baseline is summarized in Table 1. There was a CCI score available for 2961 (91.6 %) of the transplant recipients with a median score of 1 (IQR of 1-3) at time of transplantation.

Until February 28th 2021, a total of 796/3231 (24.6 %) have died during follow-up. The total follow-up time for HSCT and SOT recipients is 5192 and 8840 years, median 2.9 (IQR 0.9 – 6.2) and 4.3 (IQR 1.8 – 7.2), respectively. Follow-up of those who are alive is ongoing.

Findings to Date

With the right regulatory approvals, researchers can get access to the clinical data collected in the MATCH program. Since 2011 until 2023, clinical data from the MATCH program have been the basis of more than 50 scientific publications. A full publication list is available in the supplementary material.

CMV

The implementation of MATCH succeeded in reducing CMV disease among non-lung SOT recipients as demonstrated by Ekenberg et al, with an adjusted hazard ratio of 0.27 [0.11-0.63], P = 0.003, early after implementation, and an adjusted hazard ratio of 0.17 [0.06-0.52], P =0.002, late after implementation, both compared with prior to MATCH. [10]

Other elements of the CMV management in MATCH have also been studied, including the development of antiviral resistance. [10–20]

Other infections

The epidemiology of a range of other infectious diseases in transplant recipients has also been studied based on the MATCH cohort with findings amongst other: a high incidence of invasive aspergillosis the first three months after CMV infection, and a high incidence of herpes vira (CMV, EBV, Herpes simplex type 1 and 2, and Varicella Zoster) infections. [21–29]

CLASS

The CLASS study aimed to develop a method to improve our understanding of the cause of death in transplant recipients, thereby helping identify emerging trends and health challenges in transplant recipients. The method uses trained investigators to complete a case report form (CRF) on fatal cases, which is then assessed by two external reviewers, that if not in agreement are further evaluated by an expert panel. [9] This method was used in another study, finding a trend towards lower incidence of death from cardiovascular disease, graft failure and cancer over time, while non-organ specific causes did not decrease. [3] The method also identified a sub-group of transplant recipients with an increased risk of death to cancer or cardiovascular disease, namely patients with either pre- or post- diabetes mellitus. [30]

Vitamins

Some studies also examined the role of vitamins A, E, and D in the acute graft- versus-host response in HSCT patients. [31–33]

Microbiome

The role of the gut microbiome in transplant recipients have also been investigated. [34–37] One landmark study showed that the composition of the pre-transplant gut microbiome is associated with risk of acute graft-versus host disease in HSCT patients. [38]

Cancer and PTLD

Cancer in transplant recipients has been a focus area with one study finding an increased risk of de novo or secondary cancers after solid organ or allogenic haematopoietic stem cell transplantation compared to the general population. [39] One study examined the predictive value of EBV DNA in detection of posttransplant lymphoproliferative disorders (PTLD) in transplant recipients and investigated how addition of other variables in the model could improve prediction of PTLD. [40] Another study examined early- and late-onset PTLD among adult kidney and liver transplant recipients [41], and in the same year a risk score for PTLD in SOT-recipients was developed and validated. [42]

Other research areas

Other studies based on the clinical data from the MATCH program investigated the clinical utility of different medical devices and scoring systems, different biomarkers such as ST2 and CRP, treatment options, and the role of immune reconstitution and function in transplant recipients. [42–52]

Partnerships and collaborations

MATCH has several international research collaborations. MATCH is collaborating with a transplant cohort based at the Toronto General Hospital regarding infectious complications in lung transplant recipients. MATCH is also collaborating with the Swiss Transplant Cohort study (STCS) aiming to merge more than 10,000 SOT recipients from both cohorts to evaluate and compare outcomes of different strategies against CMV infection. [54] Representatives from MATCH have also worked with the CMV Resistance Working group, a subgroup of the CMV Drug Development Forum, on definitions of resistant and refractory CMV in transplant recipients. [18]

Collaboration

MATCH encourages both local and international collaborations. Research projects seeking to use data from MATCH must be approved by the MATCH Steering Committee. Additionally, a research project must apply for all required approvals by the Danish regulatory boards according to the type

of project. For more details on how to get involved, see figure 3 and the website: (https://www.persimune.dk/How-to-get-involved).

Future Perspectives

The MATCH program has existed for 13 years, contributing a great amount of data in high granularity and of high quality that can be utilized for research purposes. This data has been used in a series of scientific publications. Future endeavors involve expanding and strengthening international collaborations to improve the quality, generalizability, and utility of evidence in the transplantation field. Large collaborations are essential to overcome limitations posed by the rarity of transplantations.

Further Details

Data Sharing Statement

Data are available on reasonable request. MATCH data are open for researchers and data access is regulated by the MATCH Steering Committee. Additionally, the research project must have all required approvals by the Danish regulatory boards according to the type of project.

Contributorship

Guarantor: MH; Conceptualisation, writing: FVLE, CGC, MH; Formal analysis: FVLE, SZ, NN; Review, edit, revision: KSM, NN, DDM, CM, FG, HS, MP, NAS, SSS, JM, VBC and JL. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

We thank the entire clinical team and the support team making MATCH possible. We also thank Riia Karoliina Sustarsic for her assistance with figure 3.

Funding

Research activities in the Management of Post-transplant Infections in Collaborating Hospitals (MATCH) program is funded by the Danish National Research Foundation (Grant number DNRF 126). Copenhagen University Hospital – Rigshospitalet, Denmark, supports the MATCH program and its quality assurance and patient treatment.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Competing Interests

None declared.

References

1. Nordham KD, Ninokawa S. The history of organ transplantation. Proc Bayl Univ Med Cent. 35(1):124–8.

2. Ugeskriftet.dk [Internet]. 2023 [cited 2023 Dec 14]. Nyretransplantation i Danmark. Available from: https://ugeskriftet.dk/videnskab/nyretransplantation-i-danmark

3. Søborg A, Reekie J, Rasmussen A, Cunha-Bang CD, Gustafsson F, Rossing K, et al. Trends in underlying causes of death in solid organ transplant recipients between 2010 and 2020: Using the CLASS method for determining specific causes of death. PloS One. 2022;17(7):e0263210.

4. Fishman JA. Infection in Organ Transplantation. Am J Transplant. 2017;17(4):856–79.

5. Azar MM, Turbett S, Gaston D, Gitman M, Razonable R, Koo S, et al. A consensus conference to define the utility of advanced infectious disease diagnostics in solid organ transplant recipients. Am J Transplant. 2022 Dec 1;22(12):3150–69.

6. Nelson J, Alvey N, Bowman L, Schulte J, Segovia MC, McDermott J, et al. Consensus recommendations for use of maintenance immunosuppression in solid organ transplantation: Endorsed by the American College of Clinical Pharmacy, American Society of Transplantation, and International Society for Heart and Lung Transplantation: An executive summary. Pharmacotherapy. 2022 Aug;42(8):594–8.

7. Schmidt M, Pedersen L, Sørensen HT. The Danish Civil Registration System as a tool in epidemiology. Eur J Epidemiol. 2014 Aug;29(8):541–9.

8. Charlson ME, Carrozzino D, Guidi J, Patierno C. Charlson Comorbidity Index: A Critical Review of Clinimetric Properties. Psychother Psychosom. 2022;91(1):8–35.

9. Wareham NE, Da Cunha-Bang C, Borges ÁH, Ekenberg C, Gerstoft J, Gustafsson F, et al. Classification of death causes after transplantation (CLASS): Evaluation of methodology and initial results. Medicine (Baltimore). 2018 Jul;97(29):e11564.

10. Ekenberg C, da Cunha-Bang C, Lodding IP, Sørensen SS, Sengeløv H, Perch M, et al. Evaluation of an electronic, patient-focused management system aimed at preventing cytomegalovirus disease following solid organ transplantation. Transpl Infect Dis Off J Transplant Soc. 2020 Apr;22(2):e13252.

11. da Cunha-Bang C, Sørensen SS, Iversen M, Sengeløv H, Hillingsø JG, Rasmussen A, et al. Factors associated with the development of cytomegalovirus infection following solid organ transplantation. Scand J Infect Dis. 2011 May;43(5):360–5.

12. Cunha-Bang C da, Kirkby N, Sønderholm M, Sørensen SS, Sengeløv H, Iversen M, et al. The time course of development and impact from viral resistance against ganciclovir in cytomegalovirus infection. Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg. 2013 Feb;13(2):458–66.

13. Lodding IP, Sengeløv H, da Cunha-Bang C, Iversen M, Rasmussen A, Gustafsson F, et al. Clinical Application of Variation in Replication Kinetics During Episodes of Post-transplant Cytomegalovirus Infections. EBioMedicine. 2015 Jul;2(7):699–705.

14. Lodding IP, da Cunha Bang C, Sørensen SS, Gustafsson F, Iversen M, Kirkby N, et al. Cytomegalovirus (CMV) Disease Despite Weekly Preemptive CMV Strategy for Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation. Open Forum Infect Dis. 2018 May;5(5):ofy080.

15. Lodding IP, Schultz HH, Jensen JU, Kirkby N, Perch M, Andersen C, et al. Cytomegalovirus Viral Load in Bronchoalveolar Lavage to Diagnose Lung Transplant Associated CMV Pneumonia. Transplantation. 2018 Feb;102(2):326–32.

16. Lodding IP, Mocroft A, da Cunha Bang C, Gustafsson F, Iversen M, Kirkby N, et al. Impact of CMV PCR Blips in Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation. Transplant Direct. 2018 Jun;4(6):e355.

17. Khurana MP, Lodding IP, Mocroft A, Sørensen SS, Perch M, Rasmussen A, et al. Risk Factors for Failure of Primary (Val)ganciclovir Prophylaxis Against Cytomegalovirus Infection and Disease in Solid Organ Transplant Recipients. Open Forum Infect Dis. 2019 Jun;6(6):ofz215.

18. Chemaly RF, Chou S, Einsele H, Griffiths P, Avery R, Razonable RR, et al. Definitions of Resistant and Refractory Cytomegalovirus Infection and Disease in Transplant Recipients for Use in Clinical Trials. Clin Infect Dis Off Publ Infect Dis Soc Am. 2019 Apr 8;68(8):1420–6.

19. Reekie J, Helleberg M, Ekenberg C, Khurana MP, Lodding IP, Mocroft A, et al. 1075. Absolute Lymphocyte Count as a Predictor of Cytomegalovirus (CMV) Infection and Recurrence in Hematopoietic Stem Cell Transplant (HSCT) Recipients. Open Forum Infect Dis. 2020 Dec 31;7(Suppl 1):S565.

20. Lodding IP, Jørgensen M, Bennedbæk M, Kirkby N, Naegele K, Gustafsson F, et al. Development and Dynamics of Cytomegalovirus UL97 Ganciclovir Resistance Mutations in Transplant Recipients Detected by Next-Generation Sequencing. Open Forum Infect Dis. 2021 Oct;8(10):ofab462.

21. Crone CG, Rezahosseini O, Schultz HHL, Qvist T, Johansen HK, Nielsen SD, et al. Achromobacter spp. in a Cohort of Non-Selected Pre- and Post-Lung Transplant Recipients. Pathog Basel Switz. 2022 Jan 28;11(2):181.

22. Rezahosseini O, Ekenberg C, Møller DL, Sørensen SS, Wareham NE, Perch M, et al. Incidence and Impact of Parvovirus B19 Infection in Seronegative Solid Organ Transplant Recipients. J Infect Dis. 2021 Sep 1;224(5):865–9.

23. Møller DL, Sørensen SS, Perch M, Gustafsson F, Rezahosseini O, Knudsen AD, et al. Bacterial and fungal bloodstream infections in solid organ transplant recipients: results from a Danish cohort with nationwide follow-up. Clin Microbiol Infect Off Publ Eur Soc Clin Microbiol Infect Dis. 2022 Mar;28(3):391–7.

24. Rezahosseini O, Møller DL, Sørensen SS, Perch M, Gustafsson F, Gelpi M, et al. An Observational Prospective Cohort Study of Incidence and Outcome of Streptococcus pneumoniae and Hemophilus influenzae Infections in Adult Solid Organ Transplant Recipients. Microorganisms. 2021 Jun 24;9(7):1371.

25. Andreasen PB, Rezahosseini O, Møller DL, Wareham NE, Thomsen MT, Houmami R, et al. Pneumocystis jirovecii pneumonia in liver transplant recipients in an era of routine prophylaxis. Immun Inflamm Dis. 2022 Jan;10(1):93–100.

26. Møller DL, Sørensen SS, Wareham NE, Rezahosseini O, Knudsen AD, Knudsen JD, et al. Bacterial and fungal bloodstream infections in pediatric liver and kidney transplant recipients. BMC Infect Dis. 2021 Jun 8;21:541.

27. Rezahosseini O, Sørensen SS, Perch M, Ekenberg C, Møller DL, Knudsen AD, et al. Measles, Mumps, Rubella, and Varicella Zoster Virus Serology and Infections in Solid Organ Transplant Recipients During the First Year Posttransplantation. Clin Infect Dis. 2021 Dec 1;73(11):e3733–9.

28. Helleberg M, Cho D, Ekenberg C, Sørensen S, Rix M, Gustafsson F, et al. Tuberculosis among Patients Undergoing Solid Organ Transplantation or Dialysis in a Low-Endemic Country, 2004-2017. Tuberc Res Treat. 2020;2020:7636975.

29. Ilett EE, Helleberg M, Reekie J, Murray DD, Wulff SM, Khurana MP, et al. Incidence Rates and Risk Factors of Clostridioides difficile Infection in Solid Organ and Hematopoietic Stem Cell Transplant Recipients. Open Forum Infect Dis. 2019 Apr;6(4):ofz086.

30. Dos Santos Q, Hornum M, Terrones-Campos C, Crone CG, Wareham NE, Soeborg A, et al. Posttransplantation Diabetes Mellitus Among Solid Organ Recipients in a Danish Cohort. Transpl Int Off J Eur Soc Organ Transplant. 2022;35:10352.

31. Gjærde LK, Andersen NS, Friis LS, Kornblit B, Petersen SL, Schjødt I, et al. Pretransplantation vitamin A plasma levels and risk of acute graft-versus-host disease following allogeneic hematopoietic stem cell transplantation. Bone Marrow Transplant. 2020 Jul;55(7):1457–9.

32. Gjaerde LK, Ostrowski SR, Minculescu L, Andersen NS, Friis LS, Kornblit B, et al. Vitamin E and acute graft-versus-host disease after myeloablative allogeneic hematopoietic cell transplantation. Eur J Haematol. 2021 Mar;106(3):417–24.

33. Gjærde LK, Ostrowski SR, Andersen NS, Friis LS, Kornblit B, Petersen SL, et al. Pre-transplantation plasma vitamin D levels and acute graft-versus-host disease after myeloablative hematopoietic cell transplantation in adults. Transpl Immunol. 2021 Oct;68:101437.

34. Ilett EE, Jørgensen M, Noguera-Julian M, Daugaard G, Murray DD, Helleberg M, et al. Gut microbiome comparability of fresh-frozen versus stabilized-frozen samples from hospitalized patients using 16S rRNA gene and shotgun metagenomic sequencing. Sci Rep. 2019 Sep 16;9(1):13351.

35. Ilett EE, Jørgensen M, Noguera-Julian M, Nørgaard JC, Daugaard G, Helleberg M, et al. Associations of the gut microbiome and clinical factors with acute GVHD in allogeneic HSCT recipients. Blood Adv. 2020 Nov 24;4(22):5797–809.

36. Jørgensen M, Nørgaard JC, Ilett EE, Marandi RZ, Noguera-Julian M, Paredes R, et al. Metabolic Potential of the Gut Microbiome Is Significantly Impacted by Conditioning Regimen in Allogeneic Hematopoietic Stem Cell Transplantation Recipients. Int J Mol Sci. 2022 Jan;23(19):11115.

37. Nørgaard JC, Jørgensen M, Moestrup KS, Ilett EE, Zucco AG, Marandi RZ, et al. Impact of Antibiotic Treatment on the Gut Microbiome and its Resistome in Hematopoietic Stem Cell Transplant Recipients. J Infect Dis. 2023 Jun 28;228(1):28–36.

38. Zargari Marandi R, Jørgensen M, Ilett EE, Nørgaard JC, Noguera-Julian M, Paredes R, et al. Pre-Transplant Prediction of Acute Graft-versus-Host Disease Using the Gut Microbiome. Cells. 2022 Jan;11(24):4089.

39. Wareham NE, Li Q, Sengeløv H, Da Cunha-Bang C, Gustafsson F, Heilmann C, et al. Risk of de novo or secondary cancer after solid organ or allogeneic haematopoietic stem cell transplantation. J Cancer Res Clin Oncol. 2019 Dec;145(12):3125–35.

40. Wareham NE, Mocroft A, Sengeløv H, Da Cunha-Bang C, Gustafsson F, Heilmann C, et al. The value of EBV DNA in early detection of post-transplant lymphoproliferative disorders among solid organ and hematopoietic stem cell transplant recipients. J Cancer Res Clin Oncol. 2018 Aug;144(8):1569–80.

41. Abdulovski R, Møller DL, Knudsen AD, Sørensen SS, Rasmussen A, Nielsen SD, et al. Early- and late-onset posttransplant lymphoproliferative disorders among adult kidney and liver transplant recipients. Eur J Haematol. 2022;109(4):343–50.

42. Dos Santos Q, Wareham NE, Mocroft A, Rasmussen A, Gustafsson F, Perch M, et al. Development and Validation of a Risk Score for Post-Transplant Lymphoproliferative Disorders among Solid Organ Transplant Recipients. Cancers. 2022 Jul 4;14(13):3279.

43. Wareham NE, Lundgren JD, Da Cunha-Bang C, Gustafsson F, Iversen M, Johannesen HH, et al. The clinical utility of FDG PET/CT among solid organ transplant recipients suspected of malignancy or infection. Eur J Nucl Med Mol Imaging. 2017 Mar;44(3):421–31.

44. Crone CG, Wulff SM, Helweg-Larsen J, Bredahl P, Arendrup MC, Perch M, et al. Adverse Events Associated with Universal versus Targeted Antifungal Prophylaxis among Lung Transplant Recipients-A Nationwide Cohort Study 2010-2019. Microorganisms. 2022 Dec 15;10(12):2478.

45. Pretransplantation Plasma ST2 Level as a Prognostic Biomarker of 1-Year Nonrelapse Mortality in Allogeneic Hematopoietic Cell Transplantation - ScienceDirect [Internet]. [cited 2023 Sep 6]. Available from: https://www.sciencedirect.com/science/article/pii/S2666636722017730?via%3Dihub

46. Bugge TB, Perch M, Rezahosseini O, Crone CG, Jensen K, Schultz HH, et al. Post-Transplantation Anemia and Risk of Death Following Lung Transplantation. Transplant Proc. 2022 Oct 1;54(8):2329–36.

47. Gjærde LK, Brooks PT, Andersen NS, Friis LS, Kornblit B, Petersen SL, et al. Functional immune reconstitution early after allogeneic haematopoietic cell transplantation: A comparison of pre- and post-transplantation cytokine responses in stimulated whole blood. Scand J Immunol. 2021;94(1):e13042.

48. Drabe CH, Sørensen SS, Rasmussen A, Perch M, Gustafsson F, Rezahosseini O, et al. Immune function as predictor of infectious complications and clinical outcome in patients undergoing solid organ transplantation (the ImmuneMo:SOT study): a prospective non-interventional observational trial. BMC Infect Dis. 2019 Jul 3;19:573.

49. Minculescu L, Marquart HV, Ryder LP, Andersen NS, Schjoedt I, Friis LS, et al. Improved Overall Survival, Relapse-Free-Survival, and Less Graft-vs.-Host-Disease in Patients With High Immune Reconstitution of TCR Gamma Delta Cells 2 Months After Allogeneic Stem Cell Transplantation. Front Immunol. 2019;10:1997.

50. Nygaard M, Karlsmark T, Andersen NS, Schjødt IM, Petersen SL, Friis LS, et al. Extracorporeal photopheresis is a valuable treatment option in steroid-refractory or steroid-dependent acute graft versus host disease-experience with three different approaches. Bone Marrow Transplant. 2019 Jan;54(1):150–4.

51. Minculescu L, Kornblit BT, Friis LS, Schiødt I, Petersen SL, Andersen NS, et al. C-Reactive Protein Levels at Diagnosis of Acute Graft-versus-Host Disease Predict Steroid-Refractory Disease, Treatment-Related Mortality, and Overall Survival after Allogeneic Hematopoietic Stem Cell Transplantation. Biol Blood Marrow Transplant J Am Soc Blood Marrow Transplant. 2018 Mar;24(3):600–7.

52. Rostved AA, Lundgren JD, Hillingsø J, Peters L, Mocroft A, Rasmussen A. MELD score measured day 10 after orthotopic liver transplantation predicts death and re-transplantation within the first year. Scand J Gastroenterol. 2016 Nov;51(11):1360–6.

53. Rostved AA, Ostrowski SR, Peters L, Lundgren JD, Hillingsø J, Johansson PI, et al. Hyaluronic Acid Is a Biomarker for Allograft Dysfunction and Predicts 1-Year Graft Loss After Liver Transplantation. Transplant Proc. 2018 Dec;50(10):3635–43.

54. Stampf S, Mueller NJ, Delden C van, Pascual M, Manuel O, Banz V, et al. Cohort profile: The Swiss Transplant Cohort Study (STCS): A nationwide longitudinal cohort study of all solid organ recipients in Switzerland. BMJ Open. 2021 Dec 1;11(12):e051176.

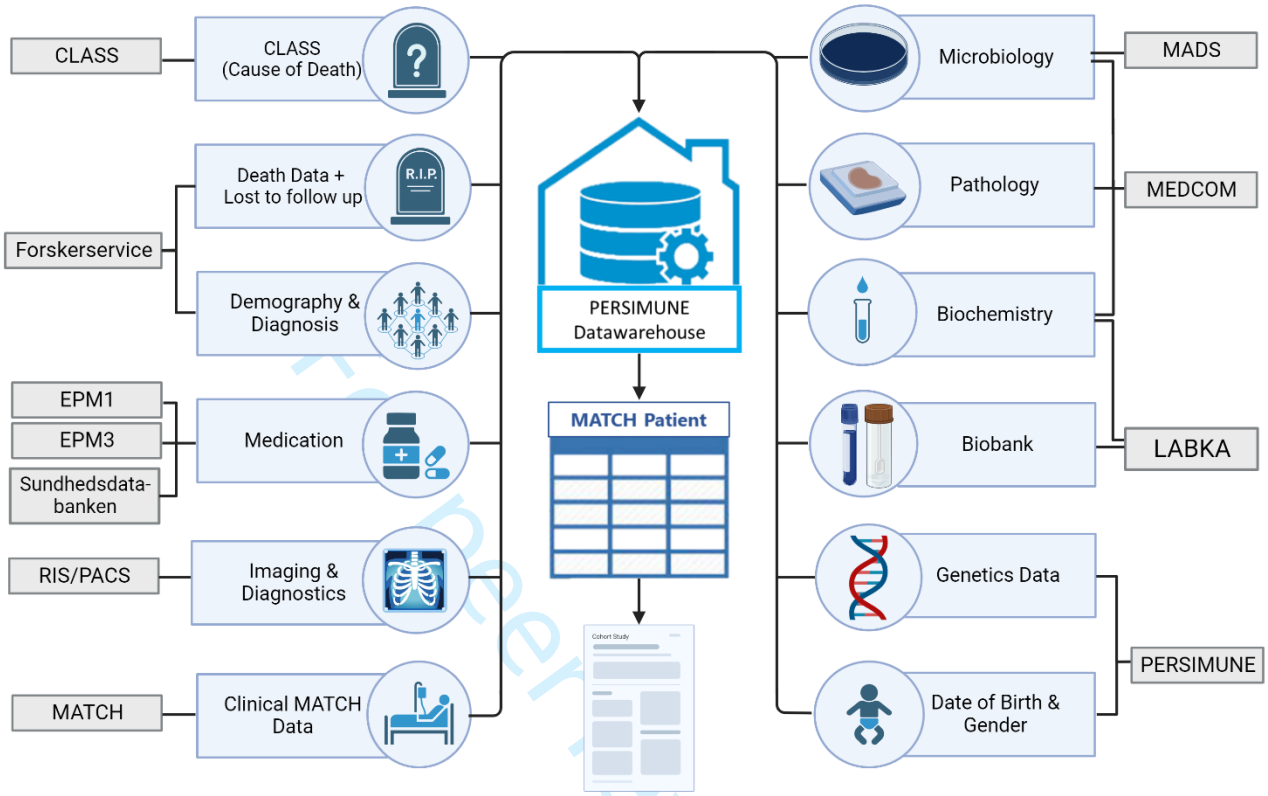
Figure 1, overview of MATCH data sources and flow. Data is collected from various local and national sources and incorporated into the PERSIMUNE Datawarehouse from where data on MATCH patients can be requested.

Table 1
Baseline characteristics of transplant recipients enrolled in MATCH between 2010 and February 2021

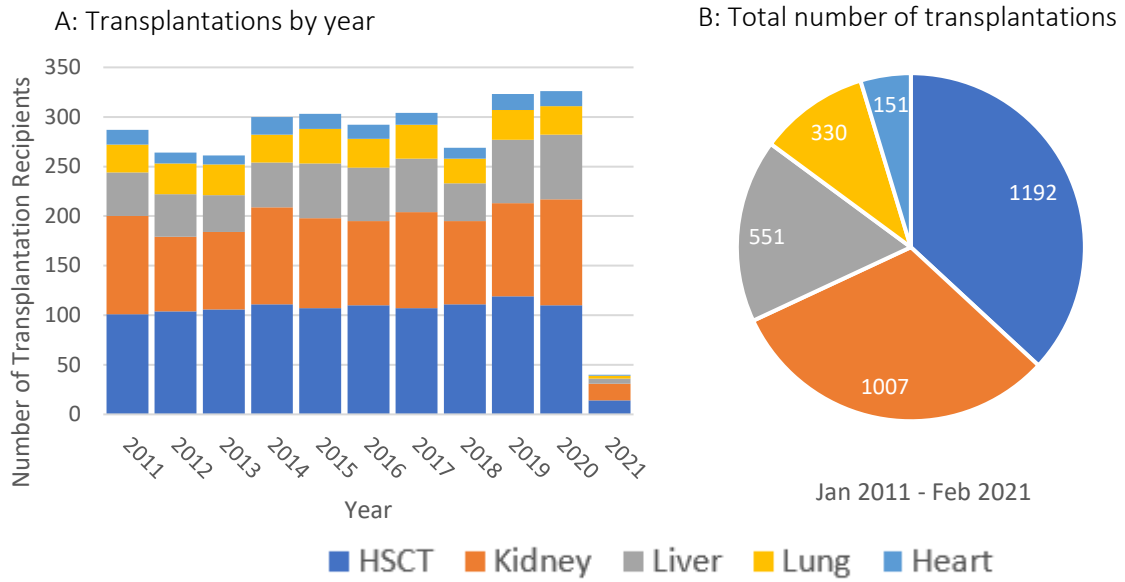
	Total	HSCT	Kidney	Liver	Lung	Heart
Transplant type, N (%)	3231	1192 (36.9)	1007 (31.2)	551 (17.1%)	330 (10.2)	151 (4.7%)
Retransplantation, N (%)	140 (4.3)	45 (3,8)	43 (4.3)	42 (7.6)	10 (3.0)	0
Age (years) at Trans-plantation, median (IQR)	50 (35,60)	50 (25,63)	50 (38, 60)	48 (34,56)	53 (44,59)	50 (33, 59)
Age < 18 years, N (%)	356 (11.0)	236 (19.8)	36 (3.6)	69 (12.5)	2 (0.6)	16 (10.6)
Sex, N (%)						
Female	1306 (40.4)	477 (40.0)	373 (37.0)	244 (44.3)	160 (48.5)	52 (34.4)
Male	1925 (59.6)	715 (60.0)	634 (63.0)	307 (55.7)	170 (51.5)	99 (65.6)
Donor/recipient CMV IgG Serostatus at transplantation, N (%)						
D+/R-	475 (14.7)	110 (9.2)	179 (17.8)	91 (16.5)	60 (18.2)	35 (23.2)
D+/R+	1334 (41.3)	427 (35.8)	468 (46.5)	268 (48.6)	129 (39.1)	42 (27.8)
D-/R+	852 (26.4)	373 (31.3)	228 (22.6)	119 (21.6)	85 (25.8)	47 (31.1)
D-/R-	492 (15.2)	252 (21.1)	117 (11.6)	62 (11.3)	46 (13.9)	15(9.9)
Unknown	78 (2.4)	30 (2.5)	15 (1.49)	11 (2.0)	10 (3.0)	12 (7.9)
Donor/recipient EBV IgG Serostatus at transplantation, N (%)						
D+R-	156 (4.8)	61 (5.1)	51 (5.1)	27 (4.9)	11 (3.3)	6 (4.0)
D+R+	2207 (68.3)	800 (67.1)	730 (72.5)	366 (66.4)	214 (64.8)	97 (64.2)
D-/R+	315 (9.7)	124 (10.4)	87 (8.6)	61 (11.1)	24 (7.3)	19 (12.6)
D-/R-	39 (1.2)	16 (1.3)	11 (1.1)	8 (1.5)	2 (0.6)	2 (1.3)
Unknown	514 (15.9)	191 (16.0)	128 (12.7)	89 (16.2)	79 (23.9)	27 (17.9)
Charlson Comorbidity Index, median (IQR)						
CCI	1 (1,3)	2 (2,2)	1 (1,2)	4 (4,5)	1 (1,2)	2 (2,3)
N (%)	2961	970	1005	546	290	150
Recipients who died, with a CLASS cause of death available						
N (%)	621 (78.0)	316 (78.8)	101 (66.8)	77 (79.4)	106 (84.1)	21 (91.3)

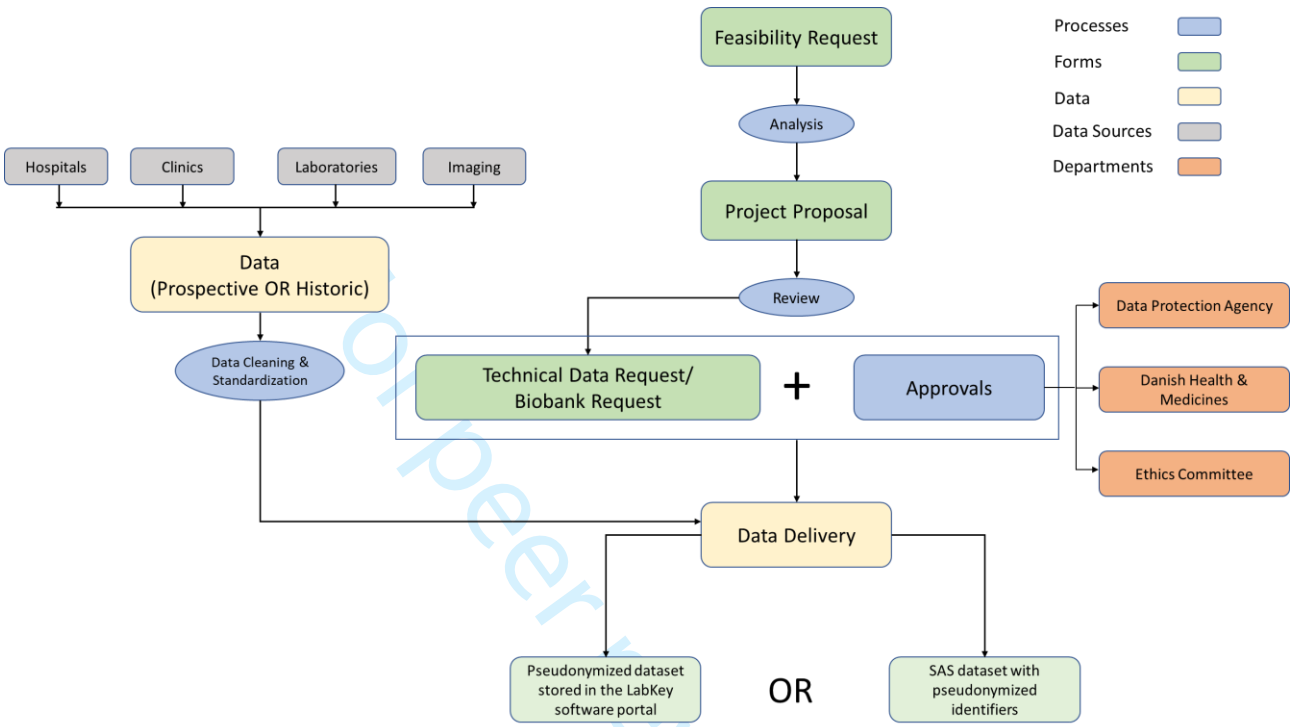
Figure 2. A: number of transplant recipients each year per type of transplantation. HSCT, Hematopoietic stem-cell transplantation recipients. B: overview of the distribution of recipients by organ type, included in MATCH from 2010 to February 2021

Figure 3, How to Obtain Data for Research in MATCH. An optional feasibility request can be made to evaluate if data of interest is available. When the researcher has confirmed that the data of interest is available, the next step is to submit a project proposal. Once the project has been approved, a data request must be made defining the patient group, all data elements required, as well as all relevant regulatory approvals. Data will be delivered in a pseudonymized form. Finally, all collaborators are asked to contribute to the ongoing data cleaning, standardization and enrichment of data used in their research project.



Created with BioRender.com





Project: 50
Cancer: 4
Early- and late-onset posttransplant lymphoproliferative disorders among adult kidney and liver transplant recipients
Development and Validation of a Risk Score for Post-Transplant Lymphoproliferative Disorders among Solid Organ Transplant Recipients
Neval E Wareham 1, Qiuju Li 2, Henrik Sengeløv 3, Caspar Da Cunha-Bang 4, Finn Gustafsson 4, Carsten Heilman
The clinical utility of PDG PET/CT among solid organ transplant recipients suspected of malignancy or infection
CMV: 11
Development and Dynamics of Cytomegalovirus UL97 Ganciclovir Resistance Mutations in Transplant Recipients Detected by Next-Generation Sequencing
Evaluation of an electronic, patient-focused management system aimed at preventing cytomegalovirus disease following solid organ transplantation
Absolute Lymphocyte Count as a Predictor of Cytomegalovirus (CMV) Infection and Recurrence in Hematopoietic Stem Cell Transplant (HSCT) Recipients

Definitions of Resistant and Refractory Cytomegalovirus Infection and Disease in Transplant Recipients for Use in Clinical Trials
Risk Factors for Failure of Primary (Val)ganciclovir Prophylaxis Against Cytomegalovirus Infection and Disease in Solid Organ Transplant Recipients
Impact of CMV PCR Blips in Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation
Cytomegalovirus (CMV) Disease Despite Weekly Preemptive CMV Strategy for Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation
Cytomegalovirus Viral Load in Bronchoalveolar Lavage to Diagnose Lung Transplant Associated CMV Pneumonia.
Clinical Application of Variation in Replication Kinetics during Episodes of Post-Transplant Cytomegalovirus Infections.
The time course of development and impact from viral resistance against ganciclovir in cytomegalovirus infection.
Factors associated with the development of cytomegalovirus infection following solid organ transplantation
Microbiome:5

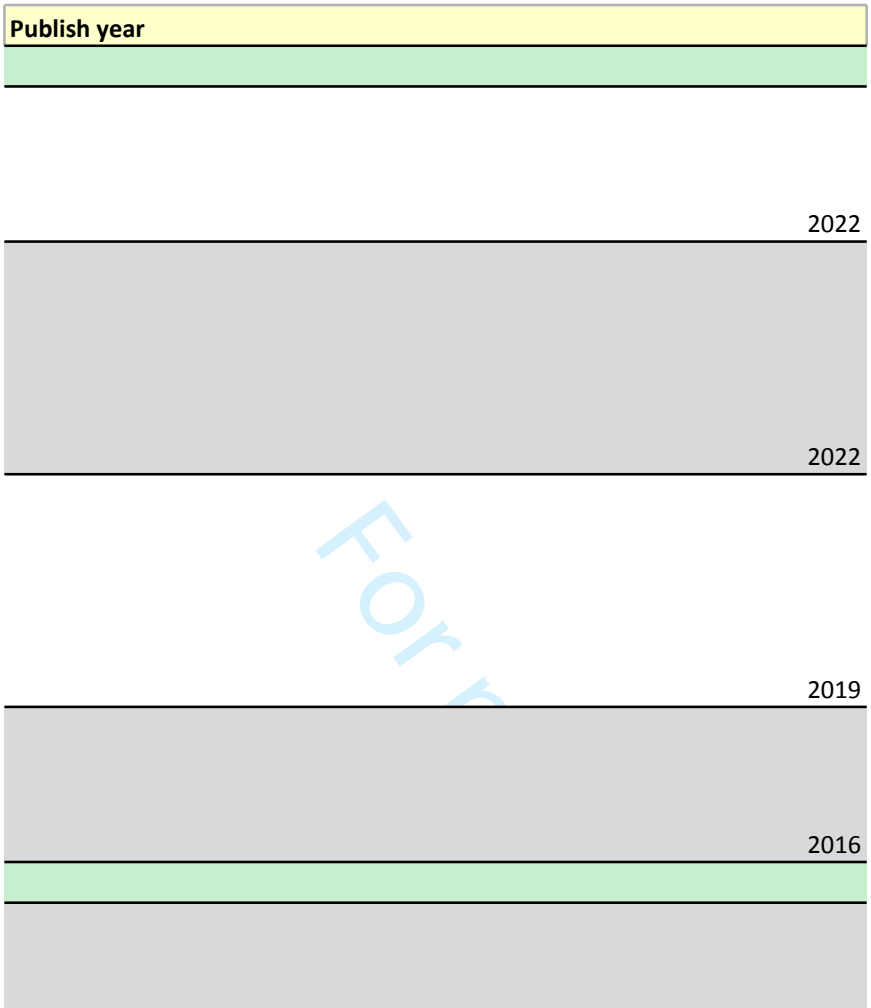
Impact of Antibiotic Treatment on the Gut Microbiome and its Resistome in Hematopoietic Stem Cell Transplant Recipients
Metabolic Potential of the Gut Microbiome Is Significantly Impacted by Conditioning Regimen in Allogeneic Hematopoietic Stem Cell Transplantation Recipients
Pre-Transplant Prediction of Acute Graft-versus-Host Disease Using the Gut Microbiome
Associations of the gut microbiome and clinical factors with acute GVHD in allogeneic HSCT recipients
Gut microbiome comparability of fresh-frozen versus stabilized-frozen samples from hospitalized patients using 16S rRNA gene and shotgun
Other Infections: 15
Associations between invasive aspergillosis and cytomegalovirus in lung transplant recipients: a nationwide cohort study
Prediction of herpes virus infections after solid organ transplantation: a prospective study of immune function
Achromobacter spp. in a Cohort of Non-Selected Pre- and Post-Lung Transplant Recipients
Adverse Events Associated with Universal versus Targeted Antifungal Prophylaxis among Lung Transplant Recipients-A Nationwide Cohort Study 2010-2019

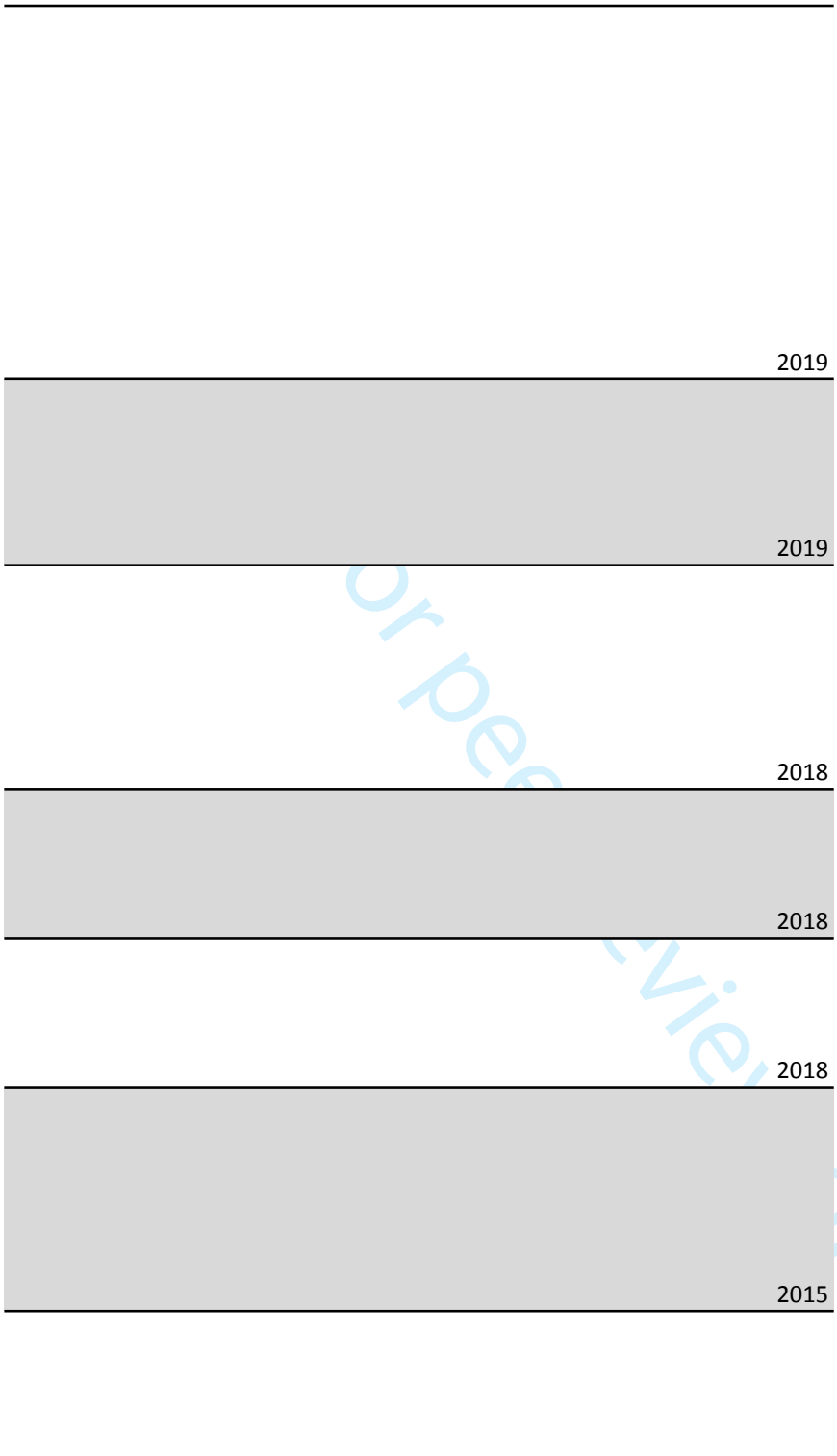
Incidence and Impact of Parvovirus B19 Infection in Seronegative Solid Organ Transplant Recipients
Bacterial and fungal bloodstream infections in solid organ transplant recipients: results from a Danish cohort with nationwide follow-up
An Observational Prospective Cohort Study of Incidence and Outcome of *Streptococcus pneumoniae* and *Hemophilus influenzae* Infections in Adult Solid Organ Transplant Recipients
Pneumocystis jirovecii pneumonia in liver transplant recipients in an era of routine prophylaxis
Bacterial and fungal bloodstream infections in pediatric liver and kidney transplant recipients
Measles, Mumps, Rubella, and Varicella Zoster Virus Serology and Infections in Solid Organ Transplant Recipients During the First Year Posttransplantation
Tuberculosis among Patients Undergoing Solid Organ Transplantation or Dialysis in a Low-Endemic Country, 2004-2017

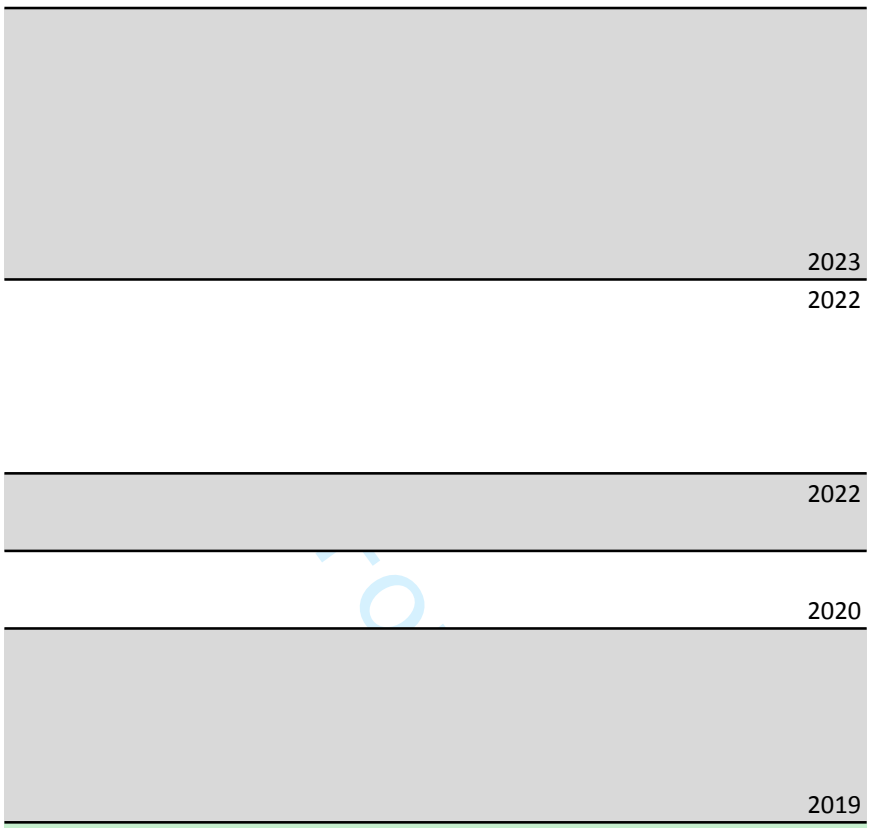
Incidence Rates and Risk Factors of *Clostridioides difficile* Infection in Solid Organ and Hematopoietic Stem Cell Transplant Recipients
The value of EBV DNA in early detection of post-transplant lymphoproliferative disorders among solid organ and hematopoietic stem cell transplant recipients.
Renal Dysfunction in a Cohort of Renal Transplant Recipients: Impact of BK Polyomavirus
Risk of infectious diseases among first-degree relatives of transplant recipients who develop CMV infection: is the infectious phenotype inheritable?
Other: 8
Pretransplantation Plasma ST2 Level as a Prognostic Biomarker of 1-Year Nonrelapse Mortality in Allogeneic Hematopoietic Cell Transplantation
Post-Transplantation Anemia and Risk of Death Following Lung Transplantation
Functional immune reconstitution early after allogeneic haematopoietic cell transplantation: A comparison of pre- and post-transplantation cytokine responses in stimulated whole blood
Immune function as predictor of infectious complications and clinical outcome in patients undergoing solid organ transplantation (the ImmuneMo:SOT study): a prospective non-interventional observational trial

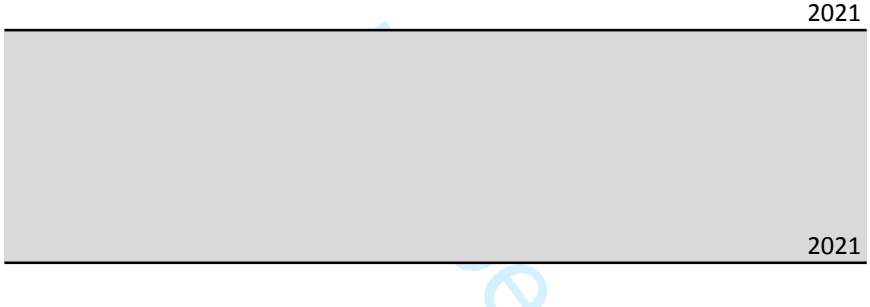
Improved Overall Survival, Relapse-Free-Survival, and Less Graft-vs.-Host-Disease in Patients With High Immune Reconstitution of TCR Gamma Delta Cells 2 Months After Allogeneic Stem Cell Transplantation
Extracorporeal photopheresis is a valuable treatment option in steroid-refractory or steroid-dependent acute graft versus host disease-experience with three different approaches
C-Reactive Protein Levels at Diagnosis of Acute Graft-versus-Host Disease Predict Steroid-Refractory Disease, Treatment-Related Mortality, and Overall Survival after Allogeneic Hematopoietic Stem Cell Transplantation.
MELD score measured day 10 after orthotopic liver transplantation predicts death and re-transplantation within the first year
CLASS: 3
Trends in underlying causes of death in solid organ transplant recipients between 2010 and 2020: Using the CLASS method for determining specific causes of death
Posttransplantation Diabetes Mellitus Among Solid Organ Recipients in a Danish Cohort
Classification of death causes after transplantation (CLASS): Evaluation of methodology and initial results
Vitamins: 4

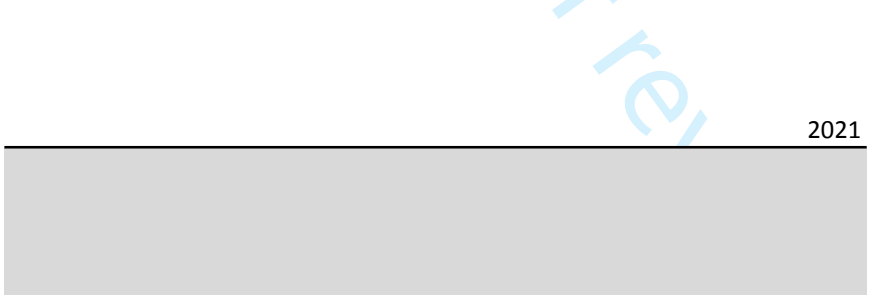
Hyaluronic Acid Is a Biomarker for Allograft Dysfunction and Predicts 1-Year Graft Loss After Liver Transplantation
Vitamin E and acute graft-versus-host disease after myeloablative allogeneic hematopoietic cell transplantation
Pretransplantation vitamin A plasma levels and risk of acute graft-versus-host disease following allogeneic hematopoietic stem cell transplantation
Pre-transplantation plasma vitamin D levels and acute graft-versus-host disease after myeloablative hematopoietic cell transplantation in adults

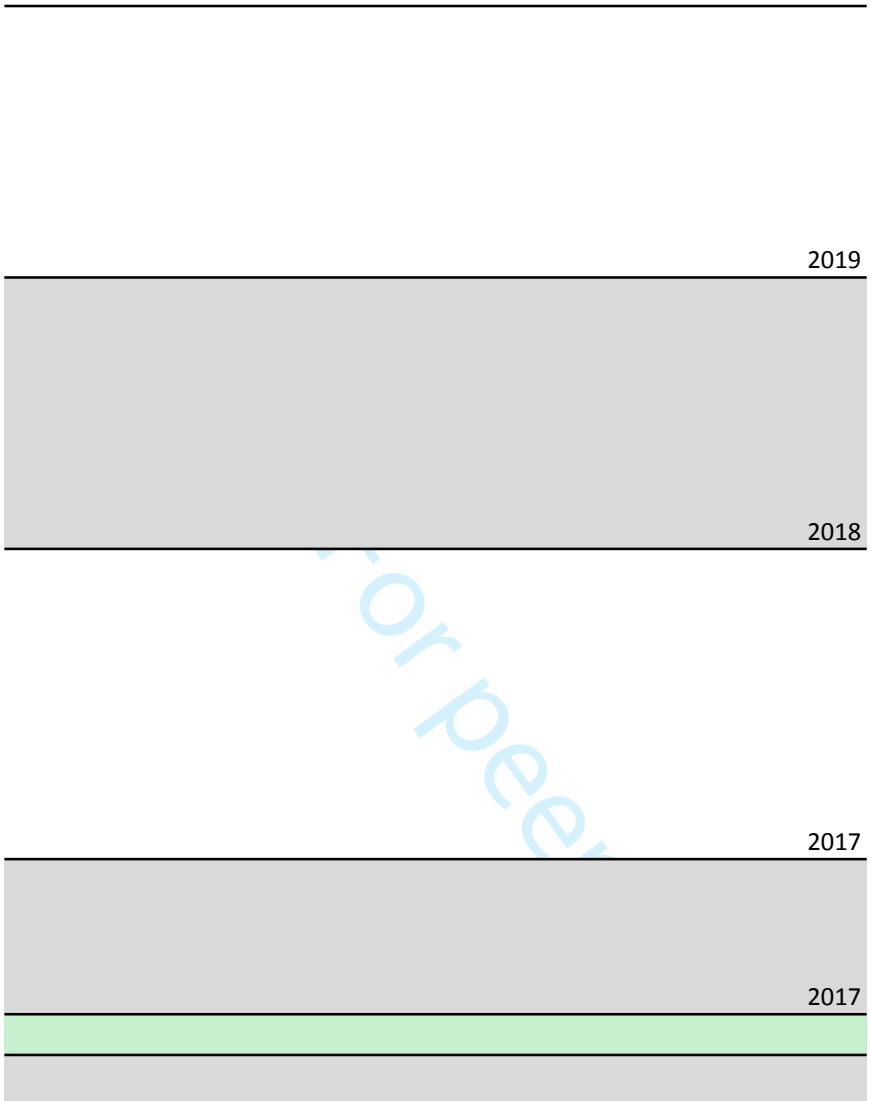


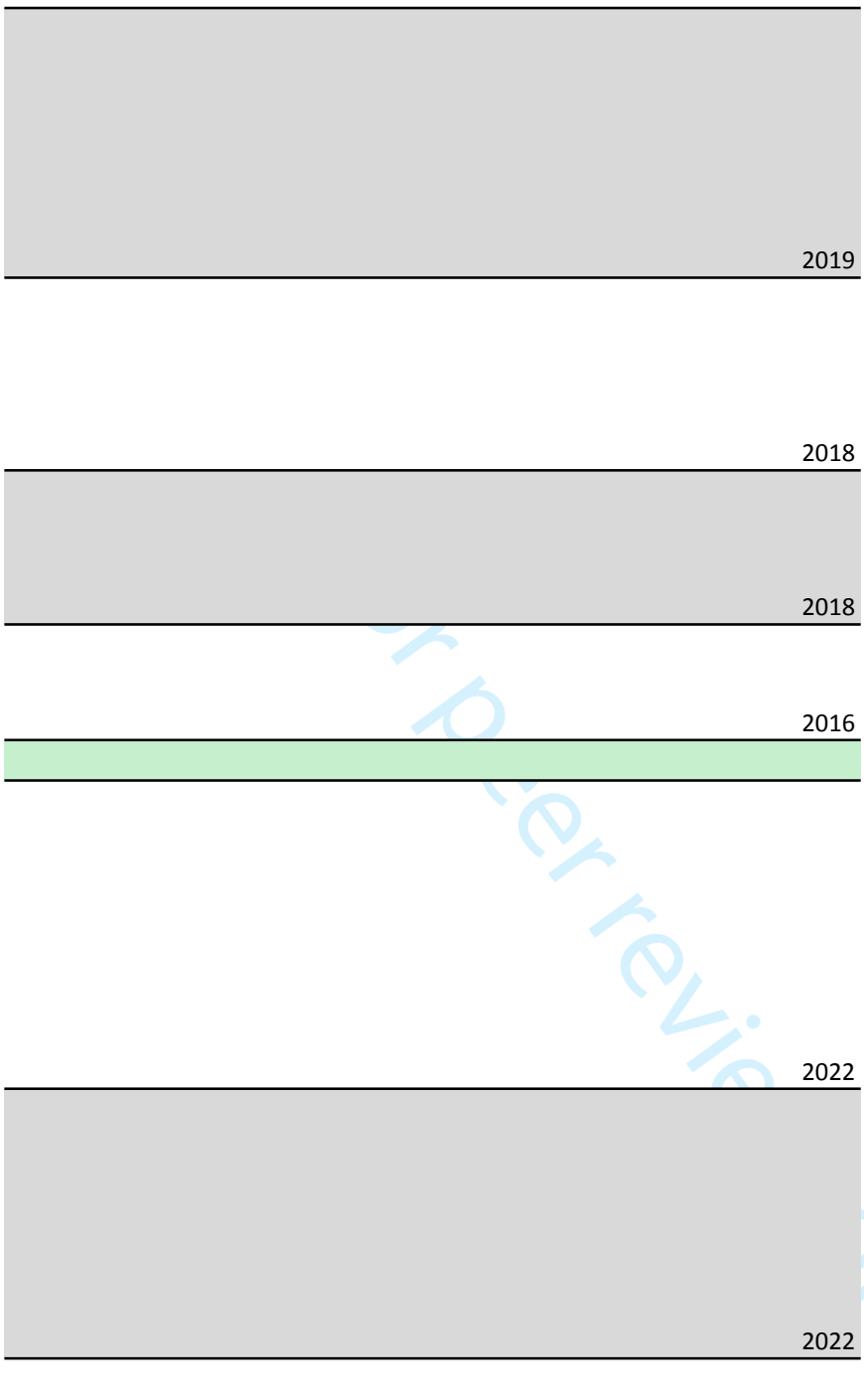


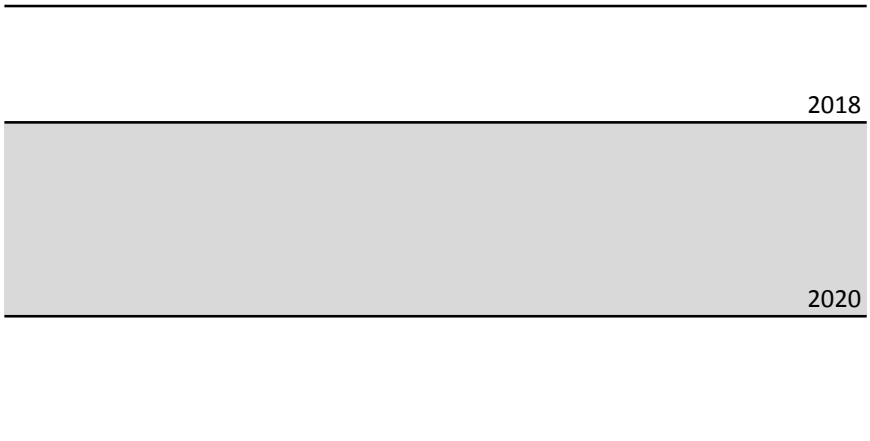












Authors
Ranya Abdulovski , Dina L Møller , Andreas D Knudsen , Søren S Sørensen , Allan Rasmussen , Susanne D Nielsen , Neval E Wareham
Quenia Dos Santos , Neval Ete Wareham , Amanda Mocroft , Allan Rasmussen , Finn Gustafsson , Michael Perch , Søren Schwartz Sørensen , Oriol Manuel , Nicolas J Müller , Jens Lundgren , Joanne Reekie
Neval E Wareham , Qiuju Li , Henrik Sengeløv , Caspar Da Cunha-Bang , Finn Gustafsson , Carsten Heilmann , Michael Perch , Allan Rasmussen , Søren Schwartz Sørensen , Amanda Mocroft , Jens D Lundgren
Neval E Wareham , J D Lundgren , C Da Cunha-Bang , F Gustafsson , M Iversen , H H Johannesen , A Kjær , A Rasmussen , H Sengeløv , S S Sørensen , B M Fischer
Isabelle P Lodding , Mette Jørgensen , Marc Bennedbæk , Nikolai Kirkby , Klaudia Naegele , Finn Gustafsson , Michael Perch , Allan Rasmussen , Henrik Sengeløv , Søren S Sørensen , Hans H Hirsch , Jens D Lundgren
Christina Ekenberg , Caspar da Cunha-Bang # , Isabelle P Lodding , Søren S Sørensen , Henrik Sengeløv , Michael Perch , Allan Rasmussen , Finn Gustafsson , Neval E Wareham , Nikolai Kirkby , Jesper Kjaer , Marie Helleberg , Joanne Reekie , Jens D Lundgren
Joanne Reekie, PhD, Marie Helleberg, MD, PhD, DMSc, Christina Ekenberg, MD, PhD, Mark P Khurana, MD, Isabelle P Lodding, MD, PhD, Amanda Mocroft, PhD, Jens Lundgren, MD, DMSc, and Henrik Sengeløv, MD, DMSc

Roy F Chemaly, Sunwen Chou, Hermann Einsele, Paul Griffiths, Robin Avery, Raymund R Razonable, Kathleen M Mullane, Camille Kotton, Jens Lundgren, Takashi E Komatsu, Peter Lischka, Filip Josephson, Cameron M Douglas, Obi Umeh, Veronica Miller, Per Ljungman,, and Resistant Definitions Working Group of the Cytomegalovirus Drug Development Forum
Mark P Khurana , Isabelle P Lodding , Amanda Mocroft , Søren S Sørensen , Michael Perch , Allan Rasmussen , Finn Gustafsson , Jens D Lundgren
Isabelle P Lodding , Amanda Mocroft , Caspar da Cunha Bang , Finn Gustafsson , Martin Iversen , Nikolai Kirkby , Michael Perch , Allan Rasmussen , Henrik Sengeløv , Søren S Sørensen , Jens D Lundgren
I P Lodding, C da Cunha Bang, S S Sørensen, F Gustafsson, M Iversen, N Kirkby, M Perch, A Rasmussen, H Sengeløv, A Mocroft, and J D Lundgren
Isabelle Paula Lodding , Hans Henrik Schultz , Jens-Ulrik Jensen , Nikolai Kirkby , Michael Perch , Claus Andersen , Jens D Lundgren , Martin Iversen
I P Lodding , H Sengeløv , C da Cunha-Bang , M Iversen , A Rasmussen , F Gustafsson , J G Downing , J Grarup , N Kirkby , C M Frederiksen , A Mocroft , S S Sørensen , J D Lundgren ; MATCH Programme Study Group
C da Cunha-Bang , N Kirkby, M Sønderholm, S S Sørensen, H Sengeløv, M Iversen, A Rasmussen, F Gustafsson, C M Frederiksen, J Kjaer, A Cozzi Lepri, J D Lundgren
Caspar da Cunha-Bang , Søren S Sørensen, Martin Iversen, Henrik Sengeløv, Jens G Hillingsø, Allan Rasmussen, Svend A Mortensen, Zoe V Fox, Nikolai S Kirkby, Claus B Christiansen, Jens D Lundgren

Jens Christian Nørgaard , Mette Jørgensen , Kasper Sommerlund Moestrup , Emma Elizabeth Ilett , Adrian Gabriel Zucco , Ramtin Z Marandi , Marc Noguera Julian , Roger Paredes , Jens D Lundgren , Henrik Sengeløv , Cameron MacPherson
Mette Jørgensen , Jens C Nørgaard , Emma E Ilett , Ramtin Z Marandi , Marc Noguera-Julian , Roger Paredes , Daniel D Murray , Jens Lundgren , Cameron Ross MacPherson , Henrik Sengeløv
Elizabeth Ilett , Jens Christian Nørgaard , Marc Noguera-Julian , Roger Paredes , Jens D Lundgren , Henrik
Julian , Jens Christian Nørgaard , Gedske
Emma E. Ilett, Mette Jørgensen, Marc Noguera-Julian , Gedske Daugaard, Daniel D. Murray, Marie Helleberg, Roger Paredes ,, Jens Lundgren, Henrik Sengeløv & Cameron MacPherson
Signe Marie Wulff , Michael Perch , Jannik Helweg-Larsen , Pia Bredahl , Maiken Cavling Arendrup , Jens Lundgren , Marie Helleberg , Cornelia Geisler Crone
Dina Leth Møller Søren Schwartz Sørensen, Omid Rezahosseini Daniel Bräuner Rasmussen Nicoline Stender Arentoft Josefine Amalie Loft Michael Perch, Finn Gustafsson, Jens Lundgren, Thomas Scheike Jenny Dahl Knudsen Sisse Rye Ostrowski, Allan Rasmussen Susanne Dam Nielsen
Cornelia Geisler Crone , Omid Rezahosseini , Hans Henrik Lawaetz Schultz , Tavs Qvist , Helle Krogh Johansen , Susanne Dam Nielsen , Michael Perch
Cornelia Geisler Crone , Signe Marie Wulff , Jannik Helweg-Larsen , Pia Bredahl , Maiken Cavling Arendrup , Michael Perch , Marie Helleberg

Omid Rezahosseini , Christina Ekenberg , Dina Leth Møller , Søren Schwartz Sørensen , Neval Ete Wareham , Michael Perch , Finn Gustafsson , Allan Rasmussen , Nikolai Kirkby , Joanne Reekie , Jens Lundgren , Susanne Dam Nielsen
Dina Leth Møller , Søren Schwartz Sørensen , Michael Perch , Finn Gustafsson , Omid Rezahosseini , Andreas Dehlbæk Knudsen , Thomas Scheike , Jenny Dahl Knudsen , Jens Lundgren , Allan Rasmussen , Susanne Dam Nielsen
Omid Rezahosseini , Dina Leth Møller , Søren Schwartz Sørensen , Michael Perch , Finn Gustafsson , Marco Gelpi , Jenny Knudsen , Marie Helleberg , Allan Rasmussen , Susanne Dam Nielsen , Zitta Barrella Harboe
Philip B Andreasen , Omid Rezahosseini , Dina L Møller , Neval E Wareham , Magda T Thomsen , Ranya Houmami , Andreas D Knudsen , Jenny Knudsen , Jørgen A L Kurtzhals , Andreas A Rostved , Christian R Pedersen , Allan Rasmussen , Susanne D Nielsen
Dina Leth Møller , Søren Schwartz Sørensen , Neval Ete Wareham , Omid Rezahosseini , Andreas Dehlbæk Knudsen , Jenny Dahl Knudsen , Allan Rasmussen , Susanne Dam Nielsen
Omid Rezahosseini , Søren Schwartz Sørensen , Michael Perch , Christina Ekenberg , Dina Leth Møller , Andreas Dehlbæk Knudsen , Nikolai Kirkby , Jens Lundgren , Isabelle P Lodding , Neval Ete Wareham , Finn Gustafsson , Allan Rasmussen , Susanne Dam Nielsen
Marie Helleberg , Daniel Cho , Christina Ekenberg , Søren Sørensen , Marianne Rix , Finn Gustafsson , Allan Rasmussen , Michael Perch , Peter H S Andersen , Jens D Lundgren , Aase Bengaard Andersen

Emma E Ilett , Marie Helleberg , Joanne Reekie , Daniel D Murray , Signe M Wulff , Mark P Khurana , Amanda Mocroft , Gedske Daugaard , Michael Perch , Allan Rasmussen , Søren S Sørensen , Finn Gustafsson , Niels Frimodt-Møller , Henrik Sengeløv , Jens Lundgren
Neval E Wareham, Amanda Mocroft, Henrik Sengeløv, Caspar Da Cunha-Bang, Finn Gustafsson, Carsten Heilmann, Martin Iversen, Nikolai S Kirkby, Allan Rasmussen, Søren Schwartz Sørensen, Jens D Lundgren, MATCH in PERSIMUNE study group
Álvaro H Borges, MD, MSc, PhD, Alessandro Cozzi-Lepri, PhD, Hans H Hirsch, MD, MSc, Caspar Da Cunha-Bang, MD, PhD, Neval Ete Wareham, MD, Casper Møller Frederiksen, MSc, PhD, Amanda Mocroft, MSc, Jens Lundgren, MD, DMSc, Søren Schwartz Sørensen, MD, DMSc, MATCH Program Study Group
C Ekenberg , I P Lodding , N E Wareham , S S Sørensen , H Sengeløv , F Gustafsson , A Rasmussen , M Perch , J D Lundgren , M Helleberg
Lars Klingen Gjærde , Sisse Rye Ostrowski , Frederikke Schierbeck , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv
Terese Brun Bugge , Michael Perch , Omid Rezahosseini , Cornelia Geisler Crone , Kristine Jensen , Hans Henrik Schultz , Pia Bredahl , Mads Hornum , Susanne Dam Nielsen , Thomas Kromann Lund
Lars Klingen Gjaerde , Patrick Terrence Brooks , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Susanne Dam Nielsen , Sisse Rye Ostrowski , Henrik Sengeløv
Camilla Heldbjerg Drabe , Søren Schwartz Sørensen , Allan Rasmussen , Michael Perch , Finn Gustafsson , Omid Rezahosseini , Jens D Lundgren , Sisse Rye Ostrowski , Susanne Dam Nielsen

Lia Minculescu , Hanne Vibeke Marquart , Lars Peter Ryder , Niels Smedegaard Andersen , Ida Schjoedt , Lone Smidstrup Friis , Brian Thomas Kornblit , Søren Lykke Petersen , Eva Haastrup , Anne Fischer-Nielsen , Joanne Reekie , Henrik Sengelov
Marietta Nygaard , Tonny Karlsmark , Niels Smedegaard Andersen , Ida Marianne Schjødt , Søren Lykke Petersen , Lone Smidstrup Friis , Brian Thomas Kornblit , Henrik Sengeløv
Lia Minculescu , Brian Thomas Kornblit , Lone Smidstrups Friis , Ida Schiødt , Soeren Lykke Petersen , Niels Smedegaard Andersen , Henrik Sengeloev
Andreas A Rostved , Jens D Lundgren , Jens Hillingsø , Lars Peters , Amanda Mocroft , Allan Rasmussen
Andreas Søborg, Joanne Reekie , Allan Rasmussen , Caspar Da Cunha-Bang , Finn Gustafsson , Kasper Rossing , Michael Perch , Paul S. Krohn , Søren S. Sørensen , Thomas K. Lund , Vibeke R. Sørensen , Christina Ekenberg , Louise Lundgren , Isabelle P. Lodding , Kasper S. Moestrup , Jens D. Lundgren, , Neval E. Wareham
Quenia Dos Santos , Mads Hornum , Cynthia Terrones-Campos , Cornelia Geisler Crone , Neval Ete Wareham , Andreas Soeborg , Allan Rasmussen , Finn Gustafsson , Michael Perch , Soeren Schwartz Soerensen , Jens Lundgren , Bo Feldt-Rasmussen , Joanne Reekie
Neval Ete Wareham , Caspar Da Cunha-Bang, Álvaro H Borges, Christina Ekenberg, Jan Gerstoft, Finn Gustafsson, Ditte Hansen, Carsten Heilmann, Marie Helleberg, Jens Hillingsø, Paul Suno Krohn, Isabelle Paula Lodding, Thomas Kromann Lund, Louise Lundgren, Amanda Mocroft, Michael Perch, Søren Lykke Petersen, Irma Petruskevicius, Allan Rasmussen, Kasper Rossing, Andreas A Rostved, Henrik Sengeløv, Vibeke Rømming Sørensen, Søren Schwartz Sørensen, Jens D Lundgren

A A Rostved , S R Ostrowski , L Peters , J D Lundgren , J Hillingsø , P I Johansson , A Rasmussen
Lars Klingen Gjaerde , Sisse Rye Ostrowski , Lia Minculescu , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv
Lars K Gjærde , Niels S Andersen , Lone S Friis , Brian Kornblit , Søren L Petersen , Ida Schjødt , Sisse R Ostrowski , Henrik Sengeløv
Lars Klingen Gjærde , Sisse Rye Ostrowski , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv

BMJ Open

Cohort Profile: The Management of Post-transplant Infections in Collaborating Hospitals (MATCH) Program - A prospective cohort of all transplant recipients at Copenhagen University Hospital – Rigshospitalet, Denmark

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-089966.R1
Article Type:	Cohort profile
Date Submitted by the Author:	22-Oct-2024
Complete List of Authors:	Esmann, Frederik; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP), Rigshospitalet Zahid, Sadaf; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Moestrup, Kasper ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Normand, Nick; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Matthews, Charlotte; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Gustafsson, Finn; Rigshospitalet, Department of Cardiology; University of Copenhagen, Department of Clinical Medicine Sengeløv, Henrik; Rigshospitalet, Department of Hematology; University of Copenhagen Faculty of Health and Medical Sciences Perch, Michael; Rigshospitalet, Department of Cardiology; University of Copenhagen, Department of Clinical Medicine Schultz, Nicolai ; Rigshospitalet, Department of Surgical Gastroenterology and Transplantation Sørensen, Søren; University of Copenhagen, Department of Clinical Medicine; Rigshospitalet, Department of Nephrology Hansen, Jesper; Herlev Hospital, Department of Nephrology Christensen, Vibeke ; Rigshospitalet, Department of Pediatrics and Adolescent Medicine Murray, Daniel ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Lundgren, J; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP); University of Copenhagen Faculty of Health and Medical Sciences Crone, Cornelia ; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP) Helleberg, Marie; Rigshospitalet, Centre of Excellence for Health, Immunity and Infections (CHIP); Rigshospitalet, Department of Infectious Diseases
Primary Subject Heading:	Epidemiology

Secondary Subject Heading:	Haematology (incl blood transfusion), Infectious diseases, Respiratory medicine, Cardiovascular medicine, Immunology (including allergy)
Keywords:	TRANSPLANT MEDICINE, INFECTIOUS DISEASES, Bone marrow transplantation < HAEMATOLOGY, EPIDEMIOLOGY, IMMUNOLOGY, VIROLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Cohort Profile: The Management of Post-transplant Infections in Collaborating Hospitals (MATCH) Program

- A prospective cohort of all transplant recipients at Copenhagen University Hospital – Rigshospitalet, Denmark

Frederik V. L. Esmann[1], Sadaf Zahid[1], Kasper Sommerlund Moestrup[1], Nick Normand[1], Charlotte Matthews[1], Finn Gustavsson[2 5], Henrik Sengeløv[3 4], Michael Perch[2 5], Nicolai Aagaard Schultz[6], Søren Schwartz Sørensen[5 7], Jesper Melchior Hansen[8], Vibeke Brix Christensen[9], Daniel D. Murray[1], Jens Lundgren[1 4], Cornelia Geisler Crone[1], Marie Helleberg[1 4 10]

[1]Centre of Excellence for Health, Immunity and Infections (CHIP), Rigshospitalet, [2] Department of Cardiology, Rigshospitalet University Hospital, Copenhagen, Denmark, [3] Department of Hematology, Rigshospitalet, Copenhagen, Denmark, [4] Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark, [5] Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark, [6] Department of Surgical Gastroenterology and Transplantation, Rigshospitalet, University of Copenhagen, 2100, Blegdamsvej, Denmark, [7] Department of Nephrology, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark, [8] Department of Nephrology, Copenhagen University Hospital, Herlev Hospital, Copenhagen, Denmark. [9] Department of Pediatrics and Adolescent Medicine, Rigshospitalet, Denmark, [10] Department of Infectious Diseases, Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark.

Abstract

Purpose The MATCH program, initiated in 2011 and still ongoing, was created to: 1) optimize the implementation of existing preventive strategies against viral infections in solid organ transplant (SOT) recipients and allogenic hematopoietic stem-cell transplant (HSCT) recipients, and 2) advance research in the field of transplantation by collecting data from a multitude of sources.

Participants All SOT and HSCT recipients at Copenhagen University Hospital, Rigshospitalet, are followed in MATCH. By February 2021, a total of 1192 HSCT recipients and 2039 SOT recipients have been included. Participants are followed life-long. An automated electronic data capture system retrieves prospective data from nationwide registries. Data from the years prior to transplantation are also collected.

Findings to Date Data entries before and after transplantation include: Biochemistry: 13,995,222 and 26,127,817; Microbiology, cultures: 242,023 and 410,558; Other microbiological analyses: 265,007 and 566,402; and Pathology: 170,884 and 200,394. There are genomic data on 2,431 transplant recipients, whole blood biobank samples from 1,003 transplant recipients and faeces biobank samples from 207 HSCT recipients. Clinical data collected in MATCH has contributed to 50 scientific papers published in peer-reviewed journals and has demonstrated success in reducing CMV-disease in SOT recipients. The program has established international collaborations with the Swiss Transplant Cohort Study and the lung transplant cohort at Toronto General Hospital.

Future Plans Enrolment into MATCH is ongoing with no planned end date for enrolment or follow-up. MATCH will continue to provide high quality data on transplant recipients and expand and strengthen international collaborations.

Word Count: 244

Introduction

The first transplantation worldwide was performed in 1954 and the first in Denmark in 1964.[1,2] The field has developed significantly since then with better surgical technique, better understanding of transplant immunology, the development of immunotherapy, and several other advances in the field of medicine. In spite of these advances, transplantations are still associated with reduced life expectancy, with cancer, allograft rejection, and infectious complications being the most important causes. [3]

Transplant procedures remain relatively rare, underscoring the importance of systematical gathering of knowledge from expansive groups or cohorts. Many aspects in the field of transplantation, including prevention of infectious disease, lack consensus on best practices due to a paucity of strong evidence. [4–6] Therefore, the Management of Post-transplant Infections in Collaborating Hospitals (MATCH) program was developed at the Copenhagen University Hospital – Rigshospitalet, Denmark.

The prospective MATCH program was initiated in 2011. It was created for two main reasons: firstly, to optimize the implementation of existing preventive strategies against viral infections in solid organ transplant (SOT) recipients and hematopoietic stem-cell transplant (HSCT) recipients, and secondly, to advance research in the field of transplantation by creating an overarching database collecting data from a multitude of data sources. The clinical part of MATCH seeks to improve outcomes of SOT patients, and has succeeded in reducing cytomegalovirus (CMV) disease by among other things implementing an electronic clinical support tool ensuring critical follow-up on both screening samples taken and not taken. [3] The MATCH cohort has been the basis of more than 50 publications published in peer-review journals so far.

This article aims to describe the profile of the MATCH cohort and provide transparency on its organization and the data available and thereby nurture further research and enhance collaborations.

Cohort Description

MATCH Organization

MATCH is anchored in the Centre of Excellence in Health, Immunity, and Infection (CHIP), at Copenhagen University Hospital – Rigshospitalet, Denmark. MATCH is led by a steering committee with two chairmen, a representative from each transplant department, a representative

for the paediatric transplant recipients, and two representatives from the Centre of Excellence in Health, Immunity, and Infection (CHIP). The steering committee acts as a governing body, overseeing scientific and clinical operations in MATCH.

All transplant recipients from Rigshospitalet are systematically enrolled in MATCH when donor and recipients are matched. This includes all patients receiving a lung and/or liver transplantation in Denmark and all recipients of HSCT, kidney and heart transplantation from Eastern Denmark. Patients have been enrolled prospectively from 2011. Additionally, all transplant recipients from January 2004 until 2010 at the MATCH-departments have been added retrospectively to the MATCH program.

Data Infrastructure

The MATCH database is operated by CHIP and embedded into the data structure of PERSIMUNE (Centre of Excellence for Personalised Medicine of Infectious Complications in Immune Deficiency. CHIP is responsible for overall operation, data processing, stability, and access control of the MATCH database.

The PERSIMUNE Datawarehouse (DWH) receives data on patients in the MATCH cohort from a multitude of sources (Figure 1). This is enabled by the Danish civil registration system (CRS). [7] Every Danish resident is registered in the CRS with a unique ten-digit Civil Personal Register (CPR) number. The CPR-number is used in all Danish registers and thereby allows linkage of data across multiple sources. Denmark has multiple national health registers, linked by the CPR-number. Provided that the relevant approvals have been obtained from the research legal department data specific for individual research projects can be imported into the DWH and thereafter linked with other data already available in the DWH in a pseudonymized combined data extract. An example is the import of data on consecutive pulmonary lung function tests on lung transplant recipients for a specific lung transplant project.

Data sources

DWH receive data from many of the national health registers, including The National Patient Register, The National Organ Donor Database, The Danish Hospital Medication Register, The Danish Microbiology Database (MiBa), The Danish Pathology Register, and The Cause of Death Register. More specifically, DWH receive data on investigations performed as part of clinical practice from: LABKA I (2005-2009) and LABKA II (2009-) provides data on biochemistry,

MEDCOM (2004-) provides data on microbiology, pathology, and additional biochemistry. Data on medication and all outpatient prescriptions is provided by EPM1 (2005-2020), EPM3 (2012-2016) and Sundheds-databanken provides data on hospital contacts and -procedures and diagnosis codes. Data on demographics, deaths and emigration are obtained from the CRS and The Cause of Death Register (2010-). MADS (2005-), a local database, provides additional microbiology data. RIS/PACS (2005-) is a local data source that provide data on imaging. The DWH obtain clinical data from electronic medical files and genetic data from other internal sources.

Quality assurance

Before being incorporated into the data stream, data from each data source is checked by a five-step procedure, involving source identification, obtaining documentation, clarification of which data columns/types to collect, establishment of data harvest, and finally an assessment of the data harvest. An ongoing data cleaning and quality assurance (QA) process is performed. This process includes, but is not limited to, generating QA-tables, generating histograms for analysis, triangulation/cross validation of data, defining rules for clean-up, testing and validating clean-up rules, defining rules for monitoring data, and implementing monitoring rules and surveillance. Furthermore, clinical biochemistry and microbiology data are grouped according to sample material and type of analysis. An example of how a biochemistry variable undergoes quality assurance is available in the supplemental material Example of Data Cleaning.

Data Enrichment

After import and cleaning of data in the DWH, PERSIMUNE performs additional data enrichment, combining data variables from data sources to create calculated variables based on standardized definitions. An example is the calculation of a Charlson comorbidity index (CCI). [8] Another example is a CMV infection algorithm used to define if a transplant recipient has a CMV infection. The algorithm checks if a recipient has two consecutive plasma CMV PCR taken within 14 days of each other with a viral load ≥ 273 IU/mL or one sample with a viral load ≥ 2730 IU/mL.

Clinical data

In overall numbers until February 28th 2021, the following data are available from the MATCH cohort: 464,783 medical diagnosis codes, 314,961 data entries on medication before recipient transplantation and 367,839 after transplantation. Biochemistry data is available with 13,995,222 entries before transplantation and 26,127,817 after. Microbiology data is available with 242,023

culture results before transplantation and 410,558 after, and data on other microbiology analysis performed is available with 265,007 results before transplantation and 566,402 after. Data on pathological examinations is available on 170,884 samples before and 200,394 after transplantation.

Some research projects result in additional data being incorporated into the DWH and is available for other research projects upon approval. One such example is the Classification of death causes after transplantation (CLASS) project. [9] CLASS is a methodology used to systematically and reliably determine and classify an accurate cause of death in all transplant recipients, than otherwise obtainable from Danish causes of death register.

Genetic Data

In 2017, after ethical approval samples from all patients in the MATCH cohort, with available material for analysis at that time point, were genotyped using the Infinium ® Global Screening Array-24 v1.0 from DeCode. In 2019, all patients in the MATCH cohort with available material for analysis were genotyped at 770558 SNP loci using a custom array from Affymetrix, designed to enrich for genes relating to immune dysfunction. In total, 2431 (75.2 %) transplant recipients have been genotyped.

Biobank

In 2015, a biobank for future research was established by PERSIMUNE, in collaboration with Rigshospitalet and the Department of clinical immunology, with samples being continuously collected from patients in the MATCH cohort (amongst others) that gave their consent. A total of 1731 patients have provided samples into the biobank. Blood samples are collected before transplantation and 1 year after transplantation, with 1207 (69.7 %) recipients having contributed at least one whole blood sample. In 2016, faeces samples were added to the collection scheme for two transplant recipient groups: HSCT and kidney transplant recipients with living donors. For HSCT recipients who have consented to this, faeces samples are collected pre-transplantation and at days 7, 14, 21, 28, and 180 after transplantation. For kidney transplant recipient, faeces samples are collected pre-transplantation, within 3 months and 3 months after transplantation. Since 2021, bronchoalveolar lavage fluid is collected and stored upon every bronchoscopy performed in lung transplant recipients who have consented to this.

Cohort participants

From 2011 until February 28th 2021, 3231 transplant recipients have been enrolled prospectively in the MATCH program with the majority being HSCT or kidney transplant recipients (Figure 2a). The number of patients enrolled has been stable over time, with a slight upwards trend (Figure 2b)

Among the 3231 transplant recipients, 4.3% had a re-transplantation. Overall, 59.6 % of transplant recipients were male. Age at transplantation was similar across the transplant groups with a mean age of 50 (IQR 35, 60). The proportion of transplant recipients under the age of 18 years, was 19.8 %, 12.5 %, 10.6 %, 4.3% and 0.6% for HSCT, liver-, heart-, kidney and lung recipients, respectively. The donor/recipient CMV and EBV serostatus in the cohort at baseline is summarized in Table 1. There was a CCI score available for 2961 (91.6 %) of the transplant recipients with a median score of 1 (IQR of 1-3) at time of transplantation.

Until February 28th 2021, a total of 796/3231 (24.6 %) have died during follow-up. In the MATCH cohort, the causes of death in the SOT recipients were cancer (19.1 %), graft rejection (18.4 %), infections (17.4 %), other organ specific or non-specific causes (15.4 %), Graft failure (11.7 %), and cardiovascular disease (10.0%). For 8% of SOT recipients, the cause of death was unknown. [3] For HSCT recipients, death from relapse was the most frequent cause of death (46.0%), followed by graft vs host disease (22.1%), other causes (13.5%), and infections (12.1%). The cause of death was unknown for 6.2% of HSCT recipients. [10]

The total follow-up time for HSCT and SOT recipients is 5192 and 8840 years, median 2.9 (IQR 0.9 – 6.2) and 4.3 (IQR 1.8 – 7.2), respectively. Follow-up of those who are alive is ongoing and independent of graft-loss.

Findings to Date

With the right regulatory approvals, researchers can get access to the clinical data collected in the MATCH program. Since 2011 until 2023, clinical data from the MATCH program have been the basis of more than 50 scientific publications. A full publication list is available in the supplemental material Full Publication List.

CMV

The implementation of MATCH succeeded in reducing CMV disease among non-lung SOT recipients as demonstrated by Ekenberg et al, with an adjusted hazard ratio of 0.27 [0.11-0.63], P =

0.003, early after implementation, and an adjusted hazard ratio of 0.17 [0.06-0.52], P =0.002, late after implementation, both compared with prior to MATCH. [11]

Other elements of the CMV management in MATCH have also been studied, including the development of antiviral resistance. [11–21]

Other infections

The epidemiology of a range of other infectious diseases in transplant recipients has also been studied based on the MATCH cohort with findings amongst other: a high incidence of invasive aspergillosis the first three months after CMV infection, and a high incidence of herpes vira (CMV, EBV, Herpes simplex type 1 and 2, and Varicella Zoster) infections. [22–30]

CLASS

The CLASS study aimed to develop a method to improve our understanding of the cause of death in transplant recipients, thereby helping identify emerging trends and health challenges in transplant recipients. The method uses trained investigators to complete a case report form (CRF) on fatal cases, which is then assessed by two external reviewers, that if not in agreement are further evaluated by an expert panel. [9] This method was used in another study, finding a trend towards lower incidence of death from cardiovascular disease, graft failure and cancer over time, while non-organ specific causes did not decrease. [3] The method also identified a sub-group of transplant recipients with an increased risk of death to cancer or cardiovascular disease, namely patients with either pre- or post- diabetes mellitus. [31]

Vitamins

Some studies also examined the role of vitamins A, E, and D in the acute graft- versus-host response in HSCT patients. [32–34]

Microbiome

The role of the gut microbiome in transplant recipients have also been investigated. [35–38] One landmark study showed that the composition of the pre-transplant gut microbiome is associated with risk of acute graft-versus host disease in HSCT patients. [39]

Cancer and PTLD

Cancer in transplant recipients has been a focus area with one study finding an increased risk of de novo or secondary cancers after solid organ or allogenic haematopoietic stem cell transplantation compared to the general population. [40] One study examined the predictive value of EBV DNA in

detection of posttransplant lymphoproliferative disorders (PTLD) in transplant recipients and investigated how addition of other variables in the model could improve prediction of PTLD. [41] Another study examined early- and late-onset PTLD among adult kidney and liver transplant recipients [42], and in the same year a risk score for PTLD in SOT-recipients was developed and validated. [43]

Other research areas

Other studies based on the clinical data from the MATCH program investigated the clinical utility of different medical devices and scoring systems, different biomarkers such as ST2 and CRP, treatment options, and the role of immune reconstitution and function in transplant recipients. [43–53]

Partnerships and collaborations

MATCH has several international research collaborations. MATCH is collaborating with a transplant cohort based at the Toronto General Hospital regarding infectious complications in lung transplant recipients. MATCH is also collaborating with the Swiss Transplant Cohort study (STCS) aiming to merge more than 10,000 SOT recipients from both cohorts to evaluate and compare outcomes of different strategies against CMV infection. [55] Representatives from MATCH have also worked with the CMV Resistance Working group, a subgroup of the CMV Drug Development Forum, on definitions of resistant and refractory CMV in transplant recipients. [19]

Collaboration

MATCH encourages both local and international collaborations. Research projects seeking to use data from MATCH must be approved by the MATCH Steering Committee. For more details, please see data sharing statement.

Future Perspectives

The MATCH program has existed for 13 years, contributing a great amount of data in high granularity and of high quality that can be utilized for research purposes. This data has been used in a series of scientific publications. Future endeavors involve expanding and strengthening international collaborations to improve the quality, generalizability, and utility of evidence in the transplantation field. Large collaborations are essential to overcome limitations posed by the rarity of transplantations.

Further Details

Strengths and limitations of this study

1. MATCH is an unselected prospective cohort with complete enrolment, encompassing all transplant recipients at Rigshospitalet, Copenhagen University Hospital, Denmark.
2. All patients followed in MATCH have a civil registration number, and linkage to the Danish civil registration system ensures almost complete life-long follow-up despite patients being transferred to other centres in Denmark.
3. The Danish civil registration system allows for linkage to multiple nationwide registries containing data on e.g. biochemistry, pathology, microbiology, imaging, prescriptions and hospital contacts, including ICD-codes for diagnoses and procedures, both from the period before and after transplantation.
4. MATCH patients, who have given consent to sampling, have provided whole blood samples, plasma samples, bronchoalveolar lavage and faeces samples to an extensive biobank.
5. MATCH enrols patients from a single centre, reducing the generalizability of findings.

Ethical Approval

This project was approved by the Centre for Regional Development (Journal-nr.: R-21018786), which approves projects seeking to retrospectively access treatment systems or electronic health records for research purposes on behalf of the Danish Data Protection Agency.

Data Sharing Statement

Data are available on reasonable request. MATCH data are open for researchers and data access is regulated by the MATCH Steering Committee. Additionally, the research project must have all required approvals by the Danish regulatory boards according to the type of project. For more details on how to get involved, see figure 3 and the website: (https://www.persimune.dk/How-to-get-involved).

Contributorship

Guarantor: MH; Conceptualisation, writing: FVLE, CGC, MH; Formal analysis: FVLE, SZ, NN; Review, edit, revision: KSM, NN, DDM, CM, FG, HS, MP, NAS, SSS, JM, VBC and JL. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

We thank the entire clinical team and the support team making MATCH possible. We also thank Riia Karoliina Sustarsic for her assistance with figure 3.

Funding

Research activities in the Management of Post-transplant Infections in Collaborating Hospitals (MATCH) program is funded by the Danish National Research Foundation (Grant number DNRF 126). Copenhagen University Hospital – Rigshospitalet, Denmark, supports the MATCH program and its quality assurance and patient treatment.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Competing Interests

None declared.

References

1. Nordham KD, Ninokawa S. The history of organ transplantation. Proc Bayl Univ Med Cent. 35(1):124–8.

2. Ugeskriftet.dk [Internet]. 2023 [cited 2023 Dec 14]. Nyretransplantation i Danmark. Available from: https://ugeskriftet.dk/videnskab/nyretransplantation-i-danmark

3. Søborg A, Reekie J, Rasmussen A, Cunha-Bang CD, Gustafsson F, Rossing K, et al. Trends in underlying causes of death in solid organ transplant recipients between 2010 and 2020: Using the CLASS method for determining specific causes of death. PloS One. 2022;17(7):e0263210.

4. Fishman JA. Infection in Organ Transplantation. Am J Transplant. 2017;17(4):856–79.

5. Azar MM, Turbett S, Gaston D, Gitman M, Razonable R, Koo S, et al. A consensus conference to define the utility of advanced infectious disease diagnostics in solid organ transplant recipients. Am J Transplant. 2022 Dec 1;22(12):3150–69.

6. Nelson J, Alvey N, Bowman L, Schulte J, Segovia MC, McDermott J, et al. Consensus recommendations for use of maintenance immunosuppression in solid organ transplantation: Endorsed by the American College of Clinical Pharmacy, American Society of Transplantation, and International Society for Heart and Lung Transplantation: An executive summary. Pharmacotherapy. 2022 Aug;42(8):594–8.

7. Schmidt M, Pedersen L, Sørensen HT. The Danish Civil Registration System as a tool in epidemiology. Eur J Epidemiol. 2014 Aug;29(8):541–9.

8. Charlson ME, Carrozzino D, Guidi J, Patierno C. Charlson Comorbidity Index: A Critical Review of Clinimetric Properties. Psychother Psychosom. 2022;91(1):8–35.

9. Wareham NE, Da Cunha-Bang C, Borges ÁH, Ekenberg C, Gerstoft J, Gustafsson F, et al. Classification of death causes after transplantation (CLASS): Evaluation of methodology and initial results. Medicine (Baltimore). 2018 Jul;97(29):e11564.

10. Søborg A, Reekie J, Sengeløv H, Da Cunha-Bang C, Lund TK, Ekenberg C, Lodding IP, Moestrup KS, Lundgren L, Lundgren JD, Wareham NE. Trends in underlying causes of death in allogeneic hematopoietic cell transplant recipients over the last decade. Eur J Haematol. 2024 May;112(5):802-809.

11. Ekenberg C, da Cunha-Bang C, Lodding IP, Sørensen SS, Sengeløv H, Perch M, et al. Evaluation of an electronic, patient-focused management system aimed at preventing cytomegalovirus disease following solid organ transplantation. Transpl Infect Dis Off J Transplant Soc. 2020 Apr;22(2):e13252.

12. da Cunha-Bang C, Sørensen SS, Iversen M, Sengeløv H, Hillingsø JG, Rasmussen A, et al. Factors associated with the development of cytomegalovirus infection following solid organ transplantation. Scand J Infect Dis. 2011 May;43(5):360–5.

13. Cunha-Bang C da, Kirkby N, Sønderholm M, Sørensen SS, Sengeløv H, Iversen M, et al. The time course of development and impact from viral resistance against ganciclovir in cytomegalovirus infection. Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg. 2013 Feb;13(2):458–66.

14. Lodding IP, Sengeløv H, da Cunha-Bang C, Iversen M, Rasmussen A, Gustafsson F, et al. Clinical Application of Variation in Replication Kinetics During Episodes of Post-transplant Cytomegalovirus Infections. EBioMedicine. 2015 Jul;2(7):699–705.

15. Lodding IP, da Cunha Bang C, Sørensen SS, Gustafsson F, Iversen M, Kirkby N, et al. Cytomegalovirus (CMV) Disease Despite Weekly Preemptive CMV Strategy for Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation. Open Forum Infect Dis. 2018 May;5(5):ofy080.

16. Lodding IP, Schultz HH, Jensen JU, Kirkby N, Perch M, Andersen C, et al. Cytomegalovirus Viral Load in Bronchoalveolar Lavage to Diagnose Lung Transplant Associated CMV Pneumonia. Transplantation. 2018 Feb;102(2):326–32.

17. Lodding IP, Mocroft A, da Cunha Bang C, Gustafsson F, Iversen M, Kirkby N, et al. Impact of CMV PCR Blips in Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation. Transplant Direct. 2018 Jun;4(6):e355.

18. Khurana MP, Lodding IP, Mocroft A, Sørensen SS, Perch M, Rasmussen A, et al. Risk Factors for Failure of Primary (Val)ganciclovir Prophylaxis Against Cytomegalovirus Infection and Disease in Solid Organ Transplant Recipients. Open Forum Infect Dis. 2019 Jun;6(6):ofz215.

19. Chemaly RF, Chou S, Einsele H, Griffiths P, Avery R, Razonable RR, et al. Definitions of Resistant and Refractory Cytomegalovirus Infection and Disease in Transplant Recipients for Use in Clinical Trials. Clin Infect Dis Off Publ Infect Dis Soc Am. 2019 Apr 8;68(8):1420–6.

20. Reekie J, Helleberg M, Ekenberg C, Khurana MP, Lodding IP, Mocroft A, et al. 1075. Absolute Lymphocyte Count as a Predictor of Cytomegalovirus (CMV) Infection and Recurrence in Hematopoietic Stem Cell Transplant (HSCT) Recipients. Open Forum Infect Dis. 2020 Dec 31;7(Suppl 1):S565.

21. Lodding IP, Jørgensen M, Bennedbæk M, Kirkby N, Naegele K, Gustafsson F, et al. Development and Dynamics of Cytomegalovirus UL97 Ganciclovir Resistance Mutations in Transplant Recipients Detected by Next-Generation Sequencing. Open Forum Infect Dis. 2021 Oct;8(10):ofab462.

22. Crone CG, Rezahosseini O, Schultz HHL, Qvist T, Johansen HK, Nielsen SD, et al. Achromobacter spp. in a Cohort of Non-Selected Pre- and Post-Lung Transplant Recipients. Pathog Basel Switz. 2022 Jan 28;11(2):181.

23. Rezahosseini O, Ekenberg C, Møller DL, Sørensen SS, Wareham NE, Perch M, et al. Incidence and Impact of Parvovirus B19 Infection in Seronegative Solid Organ Transplant Recipients. J Infect Dis. 2021 Sep 1;224(5):865–9.

24. Møller DL, Sørensen SS, Perch M, Gustafsson F, Rezahosseini O, Knudsen AD, et al. Bacterial and fungal bloodstream infections in solid organ transplant recipients: results from a Danish cohort with nationwide follow-up. Clin Microbiol Infect Off Publ Eur Soc Clin Microbiol Infect Dis. 2022 Mar;28(3):391–7.

25. Rezahosseini O, Møller DL, Sørensen SS, Perch M, Gustafsson F, Gelpi M, et al. An Observational Prospective Cohort Study of Incidence and Outcome of Streptococcus pneumoniae and Hemophilus influenzae Infections in Adult Solid Organ Transplant Recipients. Microorganisms. 2021 Jun 24;9(7):1371.

26. Andreasen PB, Rezahosseini O, Møller DL, Wareham NE, Thomsen MT, Houmami R, et al. Pneumocystis jirovecii pneumonia in liver transplant recipients in an era of routine prophylaxis. Immun Inflamm Dis. 2022 Jan;10(1):93–100.

27. Møller DL, Sørensen SS, Wareham NE, Rezahosseini O, Knudsen AD, Knudsen JD, et al. Bacterial and fungal bloodstream infections in pediatric liver and kidney transplant recipients. BMC Infect Dis. 2021 Jun 8;21:541.

28. Rezahosseini O, Sørensen SS, Perch M, Ekenberg C, Møller DL, Knudsen AD, et al. Measles, Mumps, Rubella, and Varicella Zoster Virus Serology and Infections in Solid Organ Transplant Recipients During the First Year Posttransplantation. Clin Infect Dis. 2021 Dec 1;73(11):e3733–9.

29. Helleberg M, Cho D, Ekenberg C, Sørensen S, Rix M, Gustafsson F, et al. Tuberculosis among Patients Undergoing Solid Organ Transplantation or Dialysis in a Low-Endemic Country, 2004-2017. Tuberc Res Treat. 2020;2020:7636975.

30. Ilett EE, Helleberg M, Reekie J, Murray DD, Wulff SM, Khurana MP, et al. Incidence Rates and Risk Factors of Clostridioides difficile Infection in Solid Organ and Hematopoietic Stem Cell Transplant Recipients. Open Forum Infect Dis. 2019 Apr;6(4):ofz086.

31. Dos Santos Q, Hornum M, Terrones-Campos C, Crone CG, Wareham NE, Soeborg A, et al. Posttransplantation Diabetes Mellitus Among Solid Organ Recipients in a Danish Cohort. Transpl Int Off J Eur Soc Organ Transplant. 2022;35:10352.

32. Gjærde LK, Andersen NS, Friis LS, Kornblit B, Petersen SL, Schjødt I, et al. Pretransplantation vitamin A plasma levels and risk of acute graft-versus-host disease following allogeneic hematopoietic stem cell transplantation. Bone Marrow Transplant. 2020 Jul;55(7):1457–9.

33. Gjaerde LK, Ostrowski SR, Minculescu L, Andersen NS, Friis LS, Kornblit B, et al. Vitamin E and acute graft-versus-host disease after myeloablative allogeneic hematopoietic cell transplantation. Eur J Haematol. 2021 Mar;106(3):417–24.

34. Gjærde LK, Ostrowski SR, Andersen NS, Friis LS, Kornblit B, Petersen SL, et al. Pre-transplantation plasma vitamin D levels and acute graft-versus-host disease after myeloablative hematopoietic cell transplantation in adults. Transpl Immunol. 2021 Oct;68:101437.

35. Ilett EE, Jørgensen M, Noguera-Julian M, Daugaard G, Murray DD, Helleberg M, et al. Gut microbiome comparability of fresh-frozen versus stabilized-frozen samples from hospitalized patients using 16S rRNA gene and shotgun metagenomic sequencing. Sci Rep. 2019 Sep 16;9(1):13351.

36. Ilett EE, Jørgensen M, Noguera-Julian M, Nørgaard JC, Daugaard G, Helleberg M, et al. Associations of the gut microbiome and clinical factors with acute GVHD in allogeneic HSCT recipients. Blood Adv. 2020 Nov 24;4(22):5797–809.

37. Jørgensen M, Nørgaard JC, Ilett EE, Marandi RZ, Noguera-Julian M, Paredes R, et al. Metabolic Potential of the Gut Microbiome Is Significantly Impacted by Conditioning Regimen in Allogeneic Hematopoietic Stem Cell Transplantation Recipients. Int J Mol Sci. 2022 Jan;23(19):11115.

38. Nørgaard JC, Jørgensen M, Moestrup KS, Ilett EE, Zucco AG, Marandi RZ, et al. Impact of Antibiotic Treatment on the Gut Microbiome and its Resistome in Hematopoietic Stem Cell Transplant Recipients. J Infect Dis. 2023 Jun 28;228(1):28–36.

39. Zargari Marandi R, Jørgensen M, Ilett EE, Nørgaard JC, Noguera-Julian M, Paredes R, et al. Pre-Transplant Prediction of Acute Graft-versus-Host Disease Using the Gut Microbiome. Cells. 2022 Jan;11(24):4089.

40. Wareham NE, Li Q, Sengeløv H, Da Cunha-Bang C, Gustafsson F, Heilmann C, et al. Risk of de novo or secondary cancer after solid organ or allogeneic haematopoietic stem cell transplantation. J Cancer Res Clin Oncol. 2019 Dec;145(12):3125–35.

41. Wareham NE, Mocroft A, Sengeløv H, Da Cunha-Bang C, Gustafsson F, Heilmann C, et al. The value of EBV DNA in early detection of post-transplant lymphoproliferative disorders among solid organ and hematopoietic stem cell transplant recipients. J Cancer Res Clin Oncol. 2018 Aug;144(8):1569–80.

42. Abdulovski R, Møller DL, Knudsen AD, Sørensen SS, Rasmussen A, Nielsen SD, et al. Early- and late-onset posttransplant lymphoproliferative disorders among adult kidney and liver transplant recipients. Eur J Haematol. 2022;109(4):343–50.

43. Dos Santos Q, Wareham NE, Mocroft A, Rasmussen A, Gustafsson F, Perch M, et al. Development and Validation of a Risk Score for Post-Transplant Lymphoproliferative Disorders among Solid Organ Transplant Recipients. Cancers. 2022 Jul 4;14(13):3279.

44. Wareham NE, Lundgren JD, Da Cunha-Bang C, Gustafsson F, Iversen M, Johannesen HH, et al. The clinical utility of FDG PET/CT among solid organ transplant recipients suspected of malignancy or infection. Eur J Nucl Med Mol Imaging. 2017 Mar;44(3):421–31.

45. Crone CG, Wulff SM, Helweg-Larsen J, Bredahl P, Arendrup MC, Perch M, et al. Adverse Events Associated with Universal versus Targeted Antifungal Prophylaxis among Lung Transplant Recipients-A Nationwide Cohort Study 2010-2019. Microorganisms. 2022 Dec 15;10(12):2478.

46. Pretransplantation Plasma ST2 Level as a Prognostic Biomarker of 1-Year Nonrelapse Mortality in Allogeneic Hematopoietic Cell Transplantation - ScienceDirect [Internet]. [cited 2023 Sep 6]. Available from: https://www.sciencedirect.com/science/article/pii/S2666636722017730?via%3Dihub

47. Bugge TB, Perch M, Rezahosseini O, Crone CG, Jensen K, Schultz HH, et al. Post-Transplantation Anemia and Risk of Death Following Lung Transplantation. Transplant Proc. 2022 Oct 1;54(8):2329–36.

48. Gjærde LK, Brooks PT, Andersen NS, Friis LS, Kornblit B, Petersen SL, et al. Functional immune reconstitution early after allogeneic haematopoietic cell transplantation: A comparison of pre- and post-transplantation cytokine responses in stimulated whole blood. Scand J Immunol. 2021;94(1):e13042.

49. Drabe CH, Sørensen SS, Rasmussen A, Perch M, Gustafsson F, Rezahosseini O, et al. Immune function as predictor of infectious complications and clinical outcome in patients undergoing solid organ transplantation (the ImmuneMo:SOT study): a prospective non-interventional observational trial. BMC Infect Dis. 2019 Jul 3;19:573.

50. Minculescu L, Marquart HV, Ryder LP, Andersen NS, Schjoedt I, Friis LS, et al. Improved Overall Survival, Relapse-Free-Survival, and Less Graft-vs.-Host-Disease in Patients With High Immune Reconstitution of TCR Gamma Delta Cells 2 Months After Allogeneic Stem Cell Transplantation. Front Immunol. 2019;10:1997.

51. Nygaard M, Karlsmark T, Andersen NS, Schjødt IM, Petersen SL, Friis LS, et al. Extracorporeal photopheresis is a valuable treatment option in steroid-refractory or steroid-dependent acute graft versus host disease-experience with three different approaches. Bone Marrow Transplant. 2019 Jan;54(1):150–4.

52. Minculescu L, Kornblit BT, Friis LS, Schiødt I, Petersen SL, Andersen NS, et al. C-Reactive Protein Levels at Diagnosis of Acute Graft-versus-Host Disease Predict Steroid-Refractory Disease, Treatment-

Related Mortality, and Overall Survival after Allogeneic Hematopoietic Stem Cell Transplantation. Biol Blood Marrow Transplant J Am Soc Blood Marrow Transplant. 2018 Mar;24(3):600–7.

53. Rostved AA, Lundgren JD, Hillingsø J, Peters L, Mocroft A, Rasmussen A. MELD score measured day 10 after orthotopic liver transplantation predicts death and re-transplantation within the first year. Scand J Gastroenterol. 2016 Nov;51(11):1360–6.

54. Rostved AA, Ostrowski SR, Peters L, Lundgren JD, Hillingsø J, Johansson PI, et al. Hyaluronic Acid Is a Biomarker for Allograft Dysfunction and Predicts 1-Year Graft Loss After Liver Transplantation. Transplant Proc. 2018 Dec;50(10):3635–43.

55. Stampf S, Mueller NJ, Delden C van, Pascual M, Manuel O, Banz V, et al. Cohort profile: The Swiss Transplant Cohort Study (STCS): A nationwide longitudinal cohort study of all solid organ recipients in Switzerland. BMJ Open. 2021 Dec 1;11(12):e051176.

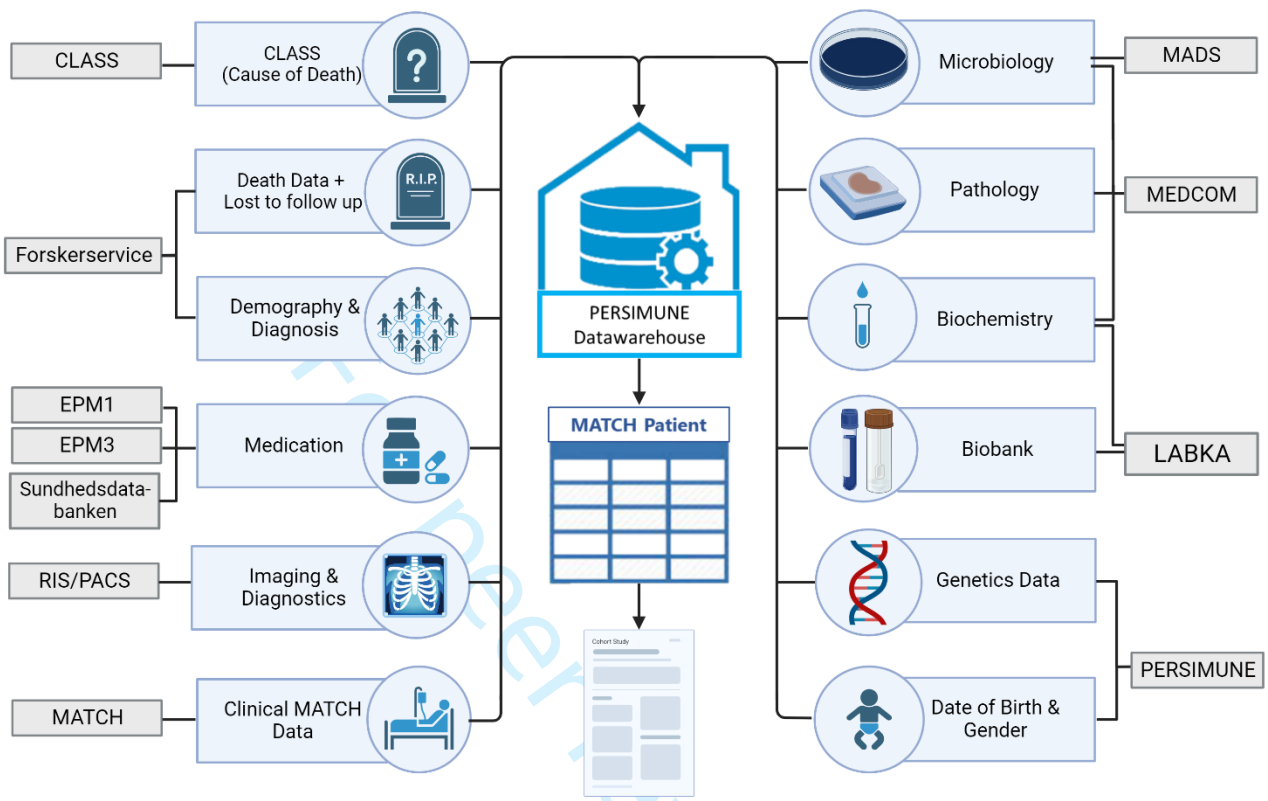
Figure 1, overview of MATCH data sources and flow. Data is collected from various local and national sources and incorporated into the PERSIMUNE Datawarehouse from where data on MATCH patients can be requested.

Table 1
Baseline characteristics of transplant recipients enrolled in MATCH between 2010 and February 2021

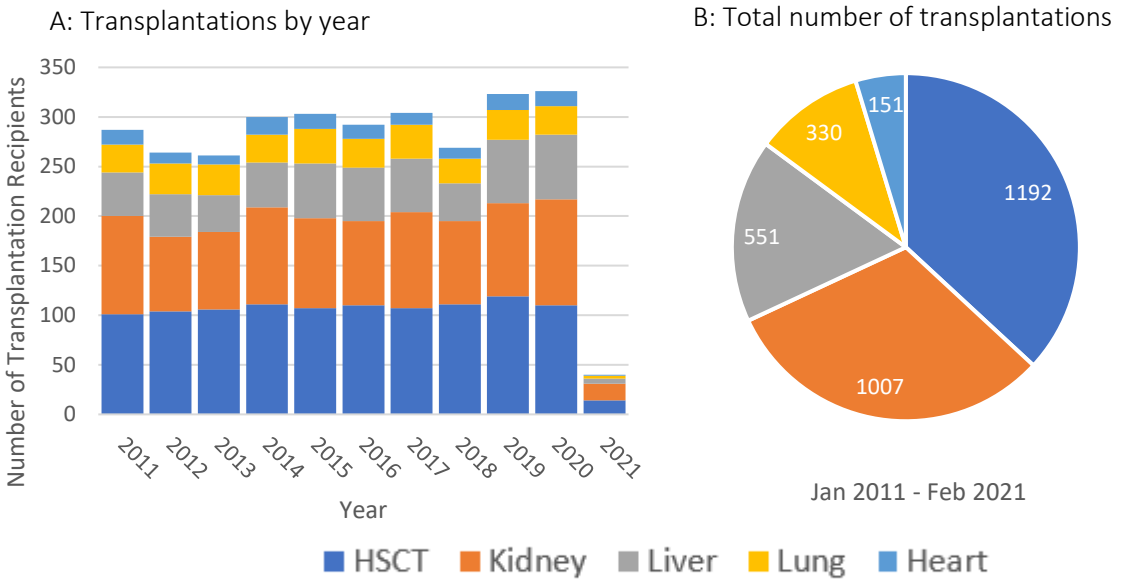
	Total	HSCT	Kidney	Liver	Lung	Heart
Transplant type, N (%)	3231	1192 (36.9)	1007 (31.2)	551 (17.1)	330 (10.2)	151 (4.7)
Myeloablative		643				
Non - myeloablative		499				
Umbilical cord blood		50				
Living donor			370	3		
Deceased donor			637	548		
Retransplantation, N (%)	140 (4.3)	45 (3,8)	43 (4.3)	42 (7.6)	10 (3.0)	0
Age (years) at transplantation, median (IQR)	50 (35,60)	50 (25,63)	50 (38, 60)	48 (34,56)	53 (44,59)	50 (33,59)
Age < 18 years, N (%)	356 (11.0)	236 (19.8)	36 (3.6)	69 (12.5)	2 (0.6)	16 (10.6)
Sex, N (%)						
Female	1306 (40.4)	477 (40.0)	373 (37.0)	244 (44.3)	160 (48.5)	52 (34.4)
Male	1925 (59.6)	715 (60.0)	634 (63.0)	307 (55.7)	170 (51.5)	99 (65.6)
Donor/recipient CMV IgG serostatus at transplantation, N (%)						
D+/R-	475 (14.7)	110 (9.2)	179 (17.8)	91 (16.5)	60 (18.2)	35 (23.2)
D+/R+	1334 (41.3)	427 (35.8)	468 (46.5)	268 (48.6)	129 (39.1)	42 (27.8)
D-/R+	852 (26.4)	373 (31.3)	228 (22.6)	119 (21.6)	85 (25.8)	47 (31.1)
D-/R-	492 (15.2)	252 (21.1)	117 (11.6)	62 (11.3)	46 (13.9)	15 (9.9)
Missing	78 (2.4)	30 (2.5)	15 (1.49)	11 (2.0)	10 (3.0)	12 (7.9)
Donor/recipient EBV IgG serostatus at transplantation, N (%)						
D+R-	156 (4.8)	61 (5.1)	51 (5.1)	27 (4.9)	11 (3.3)	6 (4.0)
D+R+	2207 (68.3)	800 (67.1)	730 (72.5)	366 (66.4)	214 (64.8)	97 (64.2)
D-/R+	315 (9.7)	124 (10.4)	87 (8.6)	61 (11.1)	24 (7.3)	19 (12.6)
D-/R-	39 (1.2)	16 (1.3)	11 (1.1)	8 (1.5)	2 (0.6)	2 (1.3)
Missing	514 (15.9)	191 (16.0)	128 (12.7)	89 (16.2)	79 (23.9)	27 (17.9)
Charlson Comorbidity Index at transplantation,						
CCI, median (IQR)	1 (1,3)	2 (2,2)	1 (1,2)	4 (4,5)	1 (1,2)	2 (2,3)
N (%)	2961 (91.6)	970 (81.4)	1005 (99.8)	546 (99.1)	290 (87.9)	150 (99.3)
Recipients who died, with a CLASS cause of death available						
N (%)	621 (78.0)	316 (78.8)	101 (66.8)	77 (79.4)	106 (84.1)	21 (91.3)

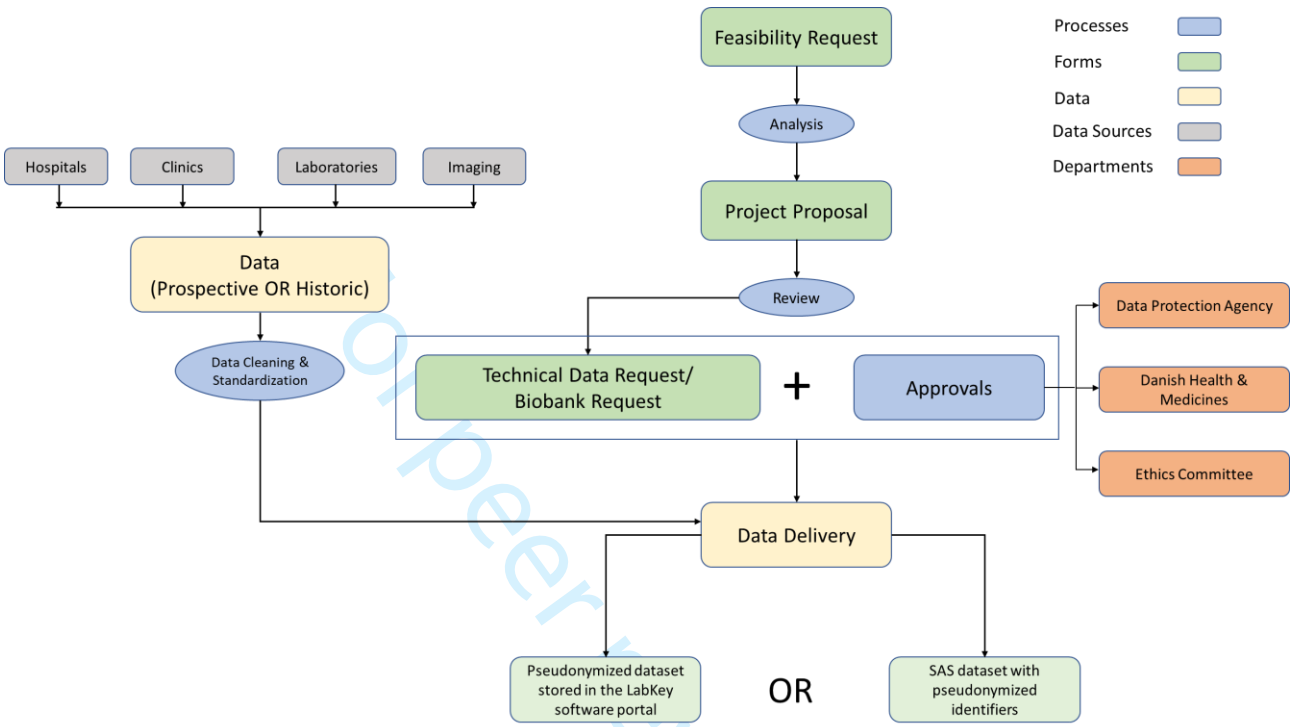
Figure 2. A: number of transplant recipients each year per type of transplantation. HSCT, Hematopoietic stem-cell transplantation recipients. B: overview of the distribution of recipients by organ type, included in MATCH from 2010 to February 2021

Figure 3, How to Obtain Data for Research in MATCH. An optional feasibility request can be made to evaluate if data of interest is available. When the researcher has confirmed that the data of interest is available, the next step is to submit a project proposal. Once the project has been approved, a data request must be made defining the patient group, all data elements required, as well as all relevant regulatory approvals. Data will be delivered in a pseudonymized form. Finally, all collaborators are asked to contribute to the ongoing data cleaning, standardization and enrichment of data used in their research project.



Created with BioRender.com





Supplemental Material MATCH Cohort Article – Example 1: data cleaning

How to find your analysis (data existence)

Analysis of how to find your codes

- Go through the entire list of NPU codes, find all relevant codes pertaining to the analysis in question
  - Deliver an excel to us with the following entries

Analysiscode	LAB_ID	Full name of analysis

- LAB_ID is the name for the analyses by HICDEP standard, or if it is not in HICDEP yet, we have to create a name that is logical and cannot be confused with others
- For local codes, make sure they do not have a twin code referring to another analysis
- Go through descriptives for clinical assessment:
  - Unit type
  - Reference interval type and values
  - Complete name of analysis
- Check whether "Operator" is always NULL for your test or if it needs to be included in data analyses (operator is for instance "<")
- Check whether any of analyses codes are ABL or POC tests for future reference (usually described in short or complete name)

Are data existence analyses complete?

Checklist for data existence

- I have found all possible NPU codes relevant for my analysis
- I have checked if there is a lab_id relevant for my analysis at HICDEP
- I have checked that none of the NPU codes I have found also refers to another analysis than the one I have investigated
- I have found no problems pertaining unit type, reference interval type and values
- I have checked the complete name of all my NPU codes and have found no possible errors
- I have checked for Operator dependent result values
- I have checked for ABL/POC tests

Rigshospitalet
Faculty of Health and Medical Sciences
PERSIMUNE
CENTRE OF EXCELLENCE FOR PERSONALISED MEDICINE OF INFECTIOUS COMPLICATIONS IN IMMUNE DEFICIENCY

How to examine data quality

Analysis of data quality

- Go through a clinical system to see if dates, values and number of tests found in PERSIMUNE matches for instance OPUS/LABKA on a single patient
- Check the range, median and IQR of the analysis result values, does it match what is expected? (across labs, across NPU codes, over time)
- Find the non-numeric test result values and check if an algorithm is needed to extract data
- Check if duplicates are introduced systematically
- Check for missing values

- For every identified problem, please formulate a solution rule for the database managers to implement

How to examine data frequencies and medians etc.

Analysis of data

- Frequencies
  - Frequency over time
  - Frequency per lab over time
  - Frequency per NPU code over time
  - Frequency per patient the first year after inclusion in PERSIMUNE
- Means/Medians
  - Mean/median over time
  - Mean/median per lab over time
  - Mean/median per NPU code over time

Project: 50
Cancer: 4
Early- and late-onset posttransplant lymphoproliferative disorders among adult kidney and liver transplant recipients
Development and Validation of a Risk Score for Post-Transplant Lymphoproliferative Disorders among Solid Organ Transplant Recipients
Neval E Wareham 1, Qiuju Li 2, Henrik Sengeløv 3, Caspar Da Cunha-Bang 4, Finn Gustafsson 4, Carsten Heilman
The clinical utility of PDG PET/CT among solid organ transplant recipients suspected of malignancy or infection
CMV: 11
Development and Dynamics of Cytomegalovirus UL97 Ganciclovir Resistance Mutations in Transplant Recipients Detected by Next-Generation Sequencing
Evaluation of an electronic, patient-focused management system aimed at preventing cytomegalovirus disease following solid organ transplantation
Absolute Lymphocyte Count as a Predictor of Cytomegalovirus (CMV) Infection and Recurrence in Hematopoietic Stem Cell Transplant (HSCT) Recipients

Definitions of Resistant and Refractory Cytomegalovirus Infection and Disease in Transplant Recipients for Use in Clinical Trials
Risk Factors for Failure of Primary (Val)ganciclovir Prophylaxis Against Cytomegalovirus Infection and Disease in Solid Organ Transplant Recipients
Impact of CMV PCR Blips in Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation
Cytomegalovirus (CMV) Disease Despite Weekly Preemptive CMV Strategy for Recipients of Solid Organ and Hematopoietic Stem Cell Transplantation
Cytomegalovirus Viral Load in Bronchoalveolar Lavage to Diagnose Lung Transplant Associated CMV Pneumonia.
Clinical Application of Variation in Replication Kinetics during Episodes of Post-Transplant Cytomegalovirus Infections.
The time course of development and impact from viral resistance against ganciclovir in cytomegalovirus infection.
Factors associated with the development of cytomegalovirus infection following solid organ transplantation
Microbiome:5

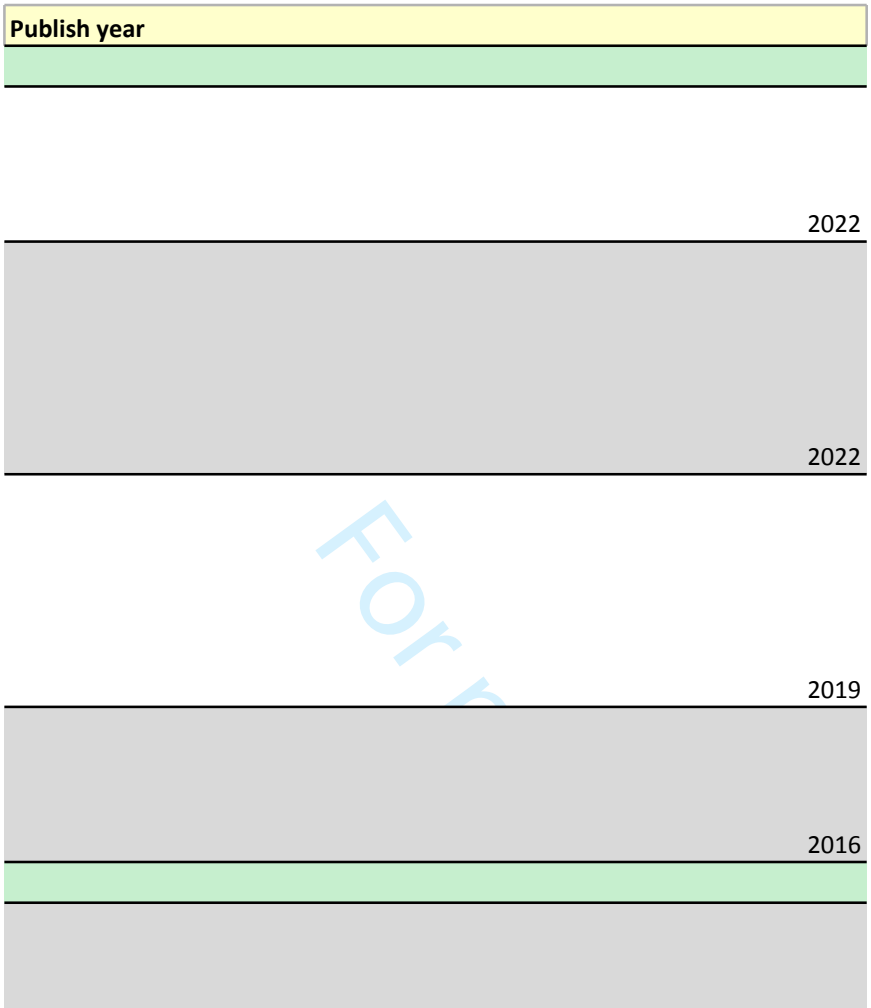
Impact of Antibiotic Treatment on the Gut Microbiome and its Resistome in Hematopoietic Stem Cell Transplant Recipients
Metabolic Potential of the Gut Microbiome Is Significantly Impacted by Conditioning Regimen in Allogeneic Hematopoietic Stem Cell Transplantation Recipients
Pre-Transplant Prediction of Acute Graft-versus-Host Disease Using the Gut Microbiome
Associations of the gut microbiome and clinical factors with acute GVHD in allogeneic HSCT recipients
Gut microbiome comparability of fresh-frozen versus stabilized-frozen samples from hospitalized patients using 16S rRNA gene and shotgun
Other Infections: 15
Associations between invasive aspergillosis and cytomegalovirus in lung transplant recipients: a nationwide cohort study
Prediction of herpes virus infections after solid organ transplantation: a prospective study of immune function
Achromobacter spp. in a Cohort of Non-Selected Pre- and Post-Lung Transplant Recipients
Adverse Events Associated with Universal versus Targeted Antifungal Prophylaxis among Lung Transplant Recipients-A Nationwide Cohort Study 2010-2019

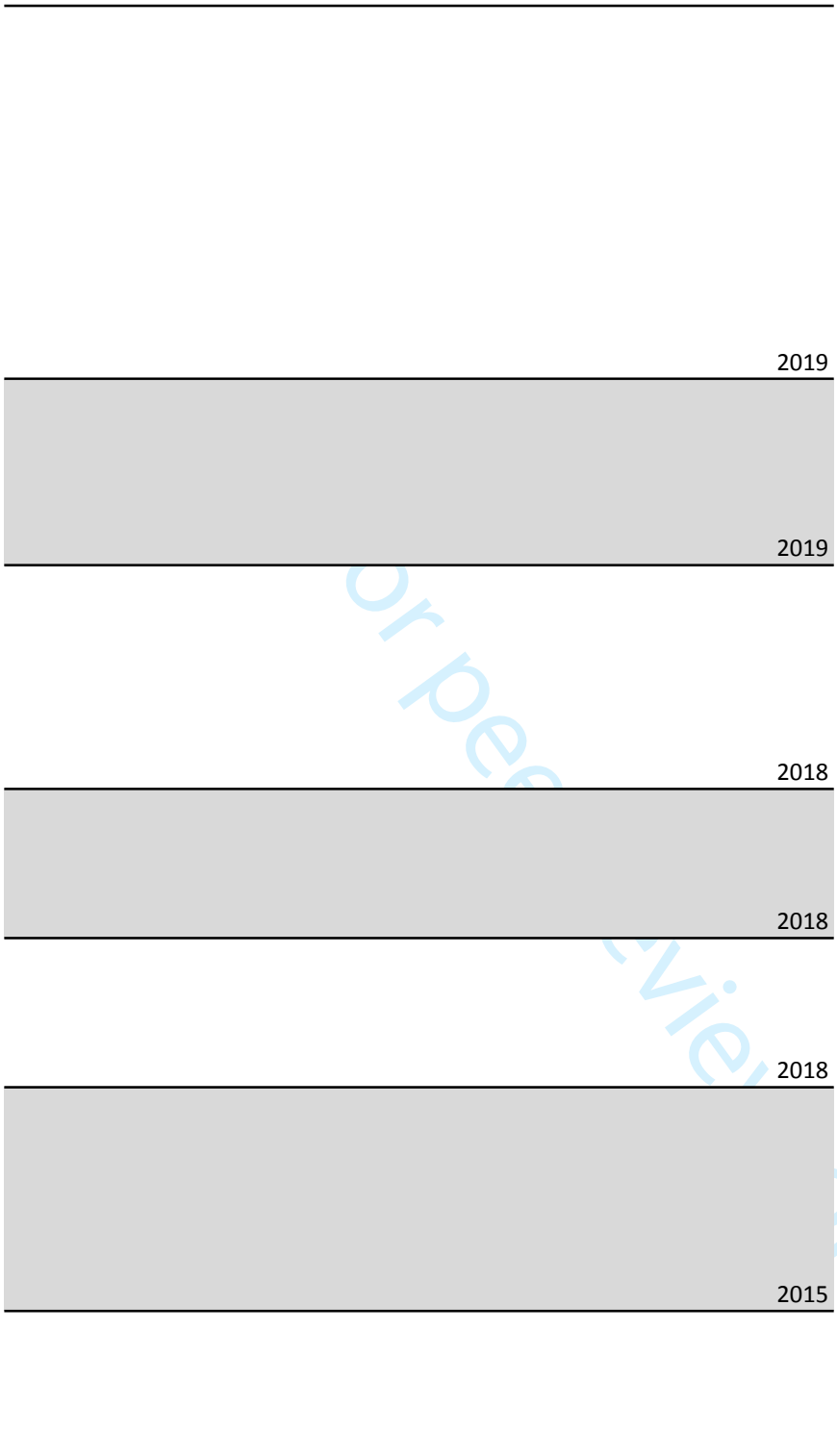
Incidence and Impact of Parvovirus B19 Infection in Seronegative Solid Organ Transplant Recipients
Bacterial and fungal bloodstream infections in solid organ transplant recipients: results from a Danish cohort with nationwide follow-up
An Observational Prospective Cohort Study of Incidence and Outcome of *Streptococcus pneumoniae* and *Hemophilus influenzae* Infections in Adult Solid Organ Transplant Recipients
Pneumocystis jirovecii pneumonia in liver transplant recipients in an era of routine prophylaxis
Bacterial and fungal bloodstream infections in pediatric liver and kidney transplant recipients
Measles, Mumps, Rubella, and Varicella Zoster Virus Serology and Infections in Solid Organ Transplant Recipients During the First Year Posttransplantation
Tuberculosis among Patients Undergoing Solid Organ Transplantation or Dialysis in a Low-Endemic Country, 2004-2017

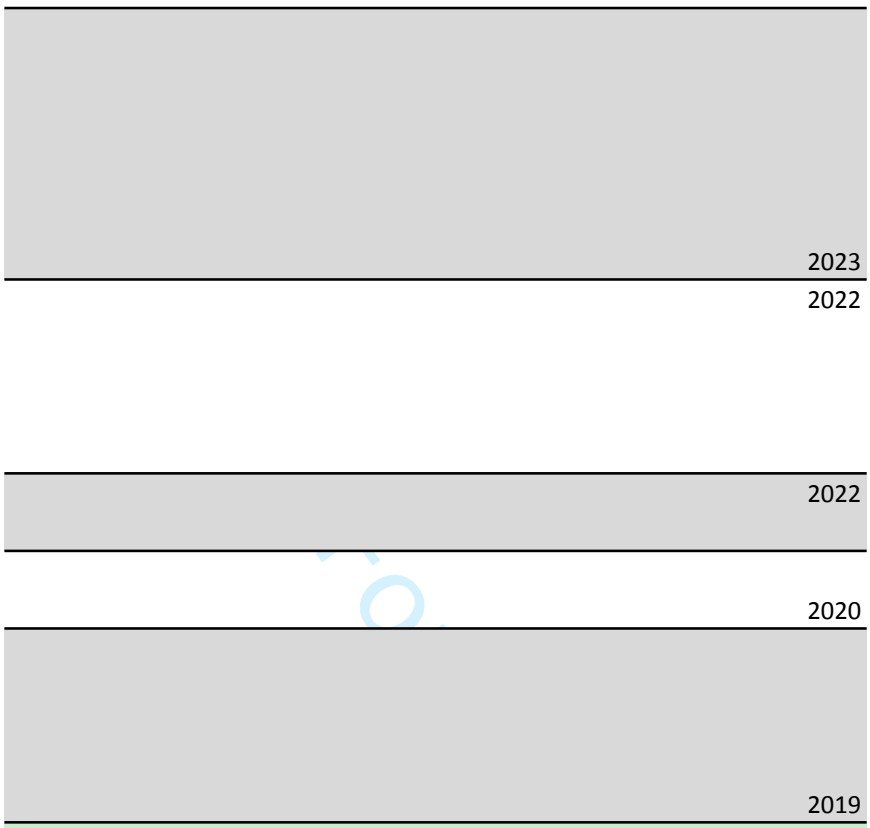
Incidence Rates and Risk Factors of *Clostridioides difficile* Infection in Solid Organ and Hematopoietic Stem Cell Transplant Recipients
The value of EBV DNA in early detection of post-transplant lymphoproliferative disorders among solid organ and hematopoietic stem cell transplant recipients.
Renal Dysfunction in a Cohort of Renal Transplant Recipients: Impact of BK Polyomavirus
Risk of infectious diseases among first-degree relatives of transplant recipients who develop CMV infection: is the infectious phenotype inheritable?
Other: 8
Pretransplantation Plasma ST2 Level as a Prognostic Biomarker of 1-Year Nonrelapse Mortality in Allogeneic Hematopoietic Cell Transplantation
Post-Transplantation Anemia and Risk of Death Following Lung Transplantation
Functional immune reconstitution early after allogeneic haematopoietic cell transplantation: A comparison of pre- and post-transplantation cytokine responses in stimulated whole blood
Immune function as predictor of infectious complications and clinical outcome in patients undergoing solid organ transplantation (the ImmuneMo:SOT study): a prospective non-interventional observational trial

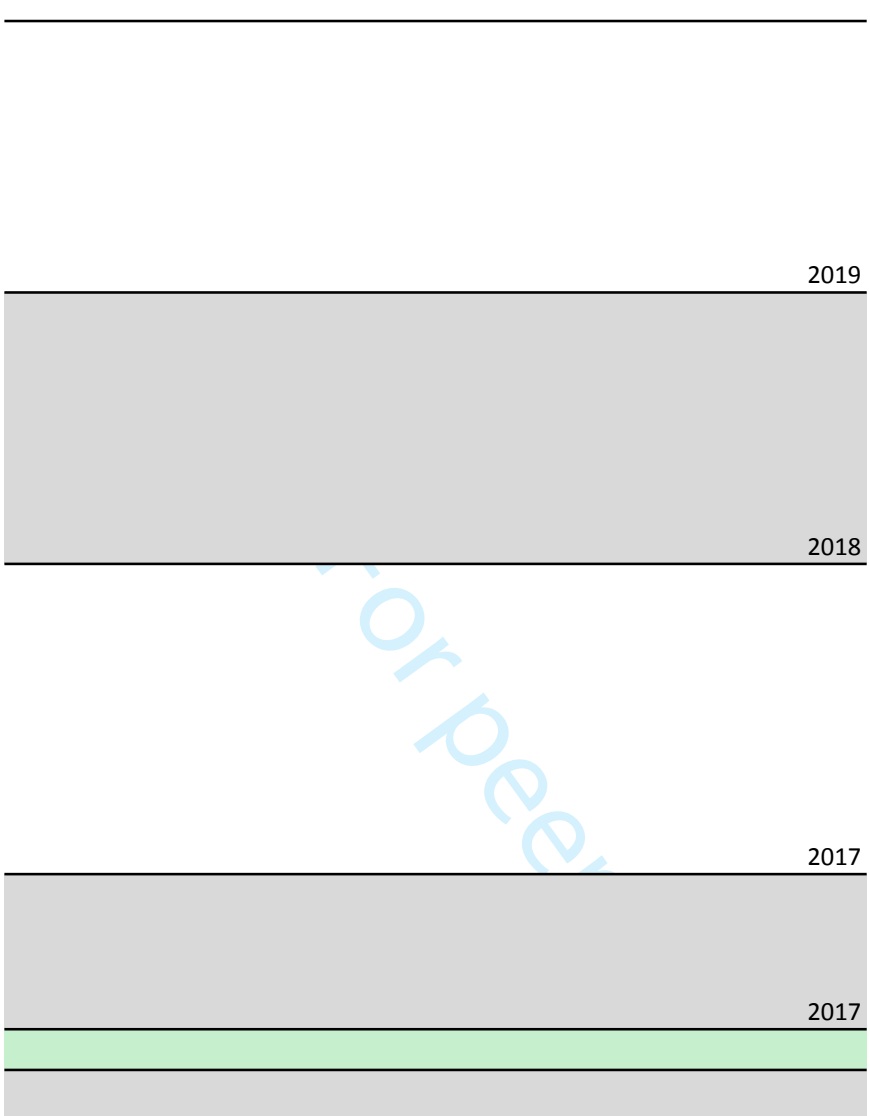
Improved Overall Survival, Relapse-Free-Survival, and Less Graft-vs.-Host-Disease in Patients With High Immune Reconstitution of TCR Gamma Delta Cells 2 Months After Allogeneic Stem Cell Transplantation
Extracorporeal photopheresis is a valuable treatment option in steroid-refractory or steroid-dependent acute graft versus host disease-experience with three different approaches
C-Reactive Protein Levels at Diagnosis of Acute Graft-versus-Host Disease Predict Steroid-Refractory Disease, Treatment-Related Mortality, and Overall Survival after Allogeneic Hematopoietic Stem Cell Transplantation.
MELD score measured day 10 after orthotopic liver transplantation predicts death and re-transplantation within the first year
CLASS: 3
Trends in underlying causes of death in solid organ transplant recipients between 2010 and 2020: Using the CLASS method for determining specific causes of death
Posttransplantation Diabetes Mellitus Among Solid Organ Recipients in a Danish Cohort
Classification of death causes after transplantation (CLASS): Evaluation of methodology and initial results
Vitamins: 4

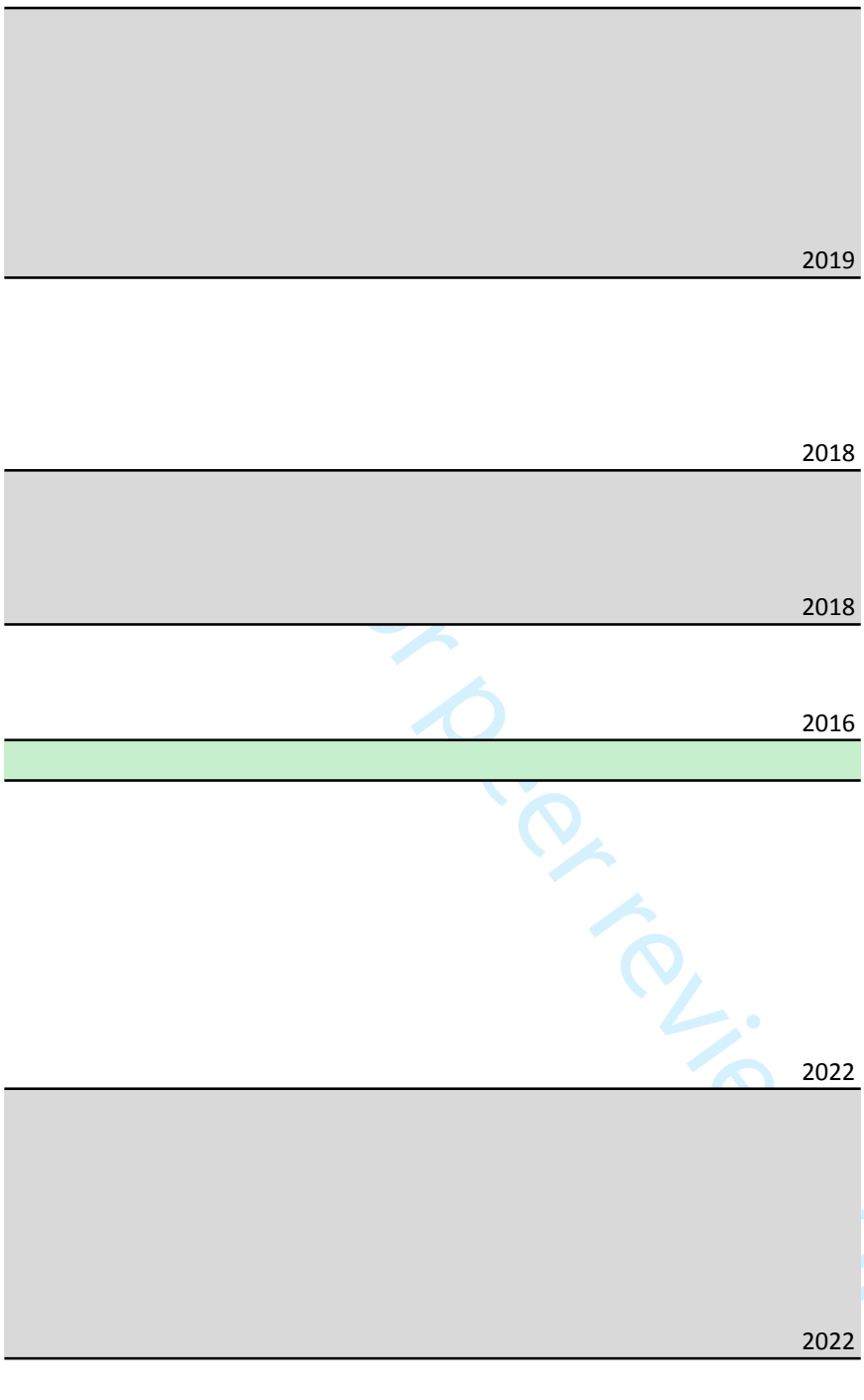
Hyaluronic Acid Is a Biomarker for Allograft Dysfunction and Predicts 1-Year Graft Loss After Liver Transplantation
Vitamin E and acute graft-versus-host disease after myeloablative allogeneic hematopoietic cell transplantation
Pretransplantation vitamin A plasma levels and risk of acute graft-versus-host disease following allogeneic hematopoietic stem cell transplantation
Pre-transplantation plasma vitamin D levels and acute graft-versus-host disease after myeloablative hematopoietic cell transplantation in adults

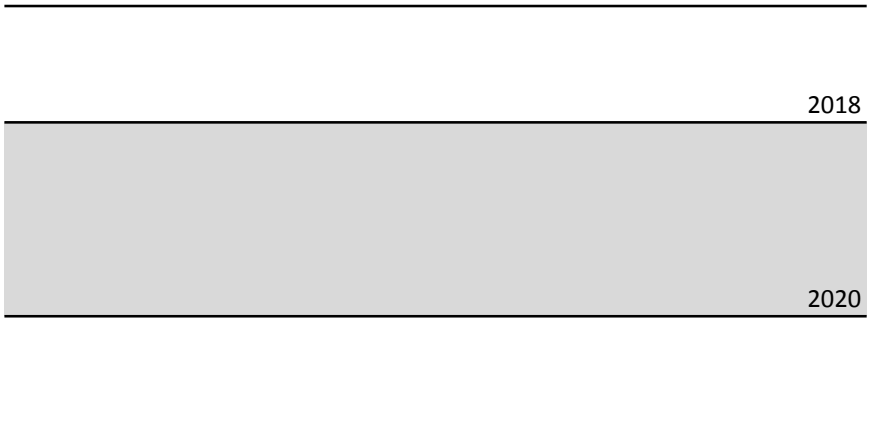












Authors
Ranya Abdulovski , Dina L Møller , Andreas D Knudsen , Søren S Sørensen , Allan Rasmussen , Susanne D Nielsen , Neval E Wareham
Quenia Dos Santos , Neval Ete Wareham , Amanda Mocroft , Allan Rasmussen , Finn Gustafsson , Michael Perch , Søren Schwartz Sørensen , Oriol Manuel , Nicolas J Müller , Jens Lundgren , Joanne Reekie
Neval E Wareham , Qiuju Li , Henrik Sengeløv , Caspar Da Cunha-Bang , Finn Gustafsson , Carsten Heilmann , Michael Perch , Allan Rasmussen , Søren Schwartz Sørensen , Amanda Mocroft , Jens D Lundgren
Neval E Wareham , J D Lundgren , C Da Cunha-Bang , F Gustafsson , M Iversen , H H Johannesen , A Kjær , A Rasmussen , H Sengeløv , S S Sørensen , B M Fischer
Isabelle P Lodding , Mette Jørgensen , Marc Bennedbæk , Nikolai Kirkby , Klaudia Naegele , Finn Gustafsson , Michael Perch , Allan Rasmussen , Henrik Sengeløv , Søren S Sørensen , Hans H Hirsch , Jens D Lundgren
Christina Ekenberg , Caspar da Cunha-Bang # , Isabelle P Lodding , Søren S Sørensen , Henrik Sengeløv , Michael Perch , Allan Rasmussen , Finn Gustafsson , Neval E Wareham , Nikolai Kirkby , Jesper Kjaer , Marie Helleberg , Joanne Reekie , Jens D Lundgren
Joanne Reekie, PhD, Marie Helleberg, MD, PhD, DMSc, Christina Ekenberg, MD, PhD, Mark P Khurana, MD, Isabelle P Lodding, MD, PhD, Amanda Mocroft, PhD, Jens Lundgren, MD, DMSc, and Henrik Sengeløv, MD, DMSc

Roy F Chemaly, Sunwen Chou, Hermann Einsele, Paul Griffiths, Robin Avery, Raymund R Razonable, Kathleen M Mullane, Camille Kotton, Jens Lundgren, Takashi E Komatsu, Peter Lischka, Filip Josephson, Cameron M Douglas, Obi Umeh, Veronica Miller, Per Ljungman,, and Resistant Definitions Working Group of the Cytomegalovirus Drug Development Forum
Mark P Khurana , Isabelle P Lodding , Amanda Mocroft , Søren S Sørensen , Michael Perch , Allan Rasmussen , Finn Gustafsson , Jens D Lundgren
Isabelle P Lodding , Amanda Mocroft , Caspar da Cunha Bang , Finn Gustafsson , Martin Iversen , Nikolai Kirkby , Michael Perch , Allan Rasmussen , Henrik Sengeløv , Søren S Sørensen , Jens D Lundgren
I P Lodding, C da Cunha Bang, S S Sørensen, F Gustafsson, M Iversen, N Kirkby, M Perch, A Rasmussen, H Sengeløv, A Mocroft, and J D Lundgren
Isabelle Paula Lodding , Hans Henrik Schultz , Jens-Ulrik Jensen , Nikolai Kirkby , Michael Perch , Claus Andersen , Jens D Lundgren , Martin Iversen
I P Lodding , H Sengeløv , C da Cunha-Bang , M Iversen , A Rasmussen , F Gustafsson , J G Downing , J Grarup , N Kirkby , C M Frederiksen , A Mocroft , S S Sørensen , J D Lundgren ; MATCH Programme Study Group
C da Cunha-Bang , N Kirkby, M Sønderholm, S S Sørensen, H Sengeløv, M Iversen, A Rasmussen, F Gustafsson, C M Frederiksen, J Kjaer, A Cozzi Lepri, J D Lundgren
Caspar da Cunha-Bang , Søren S Sørensen, Martin Iversen, Henrik Sengeløv, Jens G Hillingsø, Allan Rasmussen, Svend A Mortensen, Zoe V Fox, Nikolai S Kirkby, Claus B Christiansen, Jens D Lundgren

Jens Christian Nørgaard , Mette Jørgensen , Kasper Sommerlund Moestrup , Emma Elizabeth Ilett , Adrian Gabriel Zucco , Ramtin Z Marandi , Marc Noguera Julian , Roger Paredes , Jens D Lundgren , Henrik Sengeløv , Cameron MacPherson
Mette Jørgensen , Jens C Nørgaard , Emma E Ilett , Ramtin Z Marandi , Marc Noguera-Julian , Roger Paredes , Daniel D Murray , Jens Lundgren , Cameron Ross MacPherson , Henrik Sengeløv
Elizabeth Ilett , Jens Christian Nørgaard , Marc Noguera-Julian , Roger Paredes , Jens D Lundgren , Henrik
Julian , Jens Christian Nørgaard , Gedske
Emma E. Ilett, Mette Jørgensen, Marc Noguera-Julian , Gedske Daugaard, Daniel D. Murray, Marie Helleberg, Roger Paredes ,, Jens Lundgren, Henrik Sengeløv & Cameron MacPherson
Signe Marie Wulff , Michael Perch , Jannik Helweg-Larsen , Pia Bredahl , Maiken Cavling Arendrup , Jens Lundgren , Marie Helleberg , Cornelia Geisler Crone
Dina Leth Møller Søren Schwartz Sørensen, Omid Rezahosseini Daniel Bräuner Rasmussen Nicoline Stender Arentoft Josefine Amalie Loft Michael Perch, Finn Gustafsson, Jens Lundgren, Thomas Scheike Jenny Dahl Knudsen Sisse Rye Ostrowski, Allan Rasmussen Susanne Dam Nielsen
Cornelia Geisler Crone , Omid Rezahosseini , Hans Henrik Lawaetz Schultz , Tavs Qvist , Helle Krogh Johansen , Susanne Dam Nielsen , Michael Perch
Cornelia Geisler Crone , Signe Marie Wulff , Jannik Helweg-Larsen , Pia Bredahl , Maiken Cavling Arendrup , Michael Perch , Marie Helleberg

Omid Rezahosseini , Christina Ekenberg , Dina Leth Møller , Søren Schwartz Sørensen , Neval Ete Wareham , Michael Perch , Finn Gustafsson , Allan Rasmussen , Nikolai Kirkby , Joanne Reekie , Jens Lundgren , Susanne Dam Nielsen
Dina Leth Møller , Søren Schwartz Sørensen , Michael Perch , Finn Gustafsson , Omid Rezahosseini , Andreas Dehlbæk Knudsen , Thomas Scheike , Jenny Dahl Knudsen , Jens Lundgren , Allan Rasmussen , Susanne Dam Nielsen
Omid Rezahosseini , Dina Leth Møller , Søren Schwartz Sørensen , Michael Perch , Finn Gustafsson , Marco Gelpi , Jenny Knudsen , Marie Helleberg , Allan Rasmussen , Susanne Dam Nielsen , Zitta Barrella Harboe
Philip B Andreasen , Omid Rezahosseini , Dina L Møller , Neval E Wareham , Magda T Thomsen , Ranya Houmami , Andreas D Knudsen , Jenny Knudsen , Jørgen A L Kurtzhals , Andreas A Rostved , Christian R Pedersen , Allan Rasmussen , Susanne D Nielsen
Dina Leth Møller , Søren Schwartz Sørensen , Neval Ete Wareham , Omid Rezahosseini , Andreas Dehlbæk Knudsen , Jenny Dahl Knudsen , Allan Rasmussen , Susanne Dam Nielsen
Omid Rezahosseini , Søren Schwartz Sørensen , Michael Perch , Christina Ekenberg , Dina Leth Møller , Andreas Dehlbæk Knudsen , Nikolai Kirkby , Jens Lundgren , Isabelle P Lodding , Neval Ete Wareham , Finn Gustafsson , Allan Rasmussen , Susanne Dam Nielsen
Marie Helleberg , Daniel Cho , Christina Ekenberg , Søren Sørensen , Marianne Rix , Finn Gustafsson , Allan Rasmussen , Michael Perch , Peter H S Andersen , Jens D Lundgren , Aase Bengaard Andersen

Emma E Ilett , Marie Helleberg , Joanne Reekie , Daniel D Murray , Signe M Wulff , Mark P Khurana , Amanda Mocroft , Gedske Daugaard , Michael Perch , Allan Rasmussen , Søren S Sørensen , Finn Gustafsson , Niels Frimodt-Møller , Henrik Sengeløv , Jens Lundgren
Neval E Wareham, Amanda Mocroft, Henrik Sengeløv, Caspar Da Cunha-Bang, Finn Gustafsson, Carsten Heilmann, Martin Iversen, Nikolai S Kirkby, Allan Rasmussen, Søren Schwartz Sørensen, Jens D Lundgren, MATCH in PERSIMUNE study group
Álvaro H Borges, MD, MSc, PhD, Alessandro Cozzi-Lepri, PhD, Hans H Hirsch, MD, MSc, Caspar Da Cunha-Bang, MD, PhD, Neval Ete Wareham, MD, Casper Møller Frederiksen, MSc, PhD, Amanda Mocroft, MSc, Jens Lundgren, MD, DMSc, Søren Schwartz Sørensen, MD, DMSc, MATCH Program Study Group
C Ekenberg , I P Lodding , N E Wareham , S S Sørensen , H Sengeløv , F Gustafsson , A Rasmussen , M Perch , J D Lundgren , M Helleberg
Lars Klingen Gjærde , Sisse Rye Ostrowski , Frederikke Schierbeck , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv
Terese Brun Bugge , Michael Perch , Omid Rezahosseini , Cornelia Geisler Crone , Kristine Jensen , Hans Henrik Schultz , Pia Bredahl , Mads Hornum , Susanne Dam Nielsen , Thomas Kromann Lund
Lars Klingen Gjaerde , Patrick Terrence Brooks , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Susanne Dam Nielsen , Sisse Rye Ostrowski , Henrik Sengeløv
Camilla Heldbjerg Drabe , Søren Schwartz Sørensen , Allan Rasmussen , Michael Perch , Finn Gustafsson , Omid Rezahosseini , Jens D Lundgren , Sisse Rye Ostrowski , Susanne Dam Nielsen

Lia Minculescu , Hanne Vibeke Marquart , Lars Peter Ryder , Niels Smedegaard Andersen , Ida Schjoedt , Lone Smidstrup Friis , Brian Thomas Kornblit , Søren Lykke Petersen , Eva Haastrup , Anne Fischer-Nielsen , Joanne Reekie , Henrik Sengelov
Marietta Nygaard , Tonny Karlsmark , Niels Smedegaard Andersen , Ida Marianne Schjødt , Søren Lykke Petersen , Lone Smidstrup Friis , Brian Thomas Kornblit , Henrik Sengeløv
Lia Minculescu , Brian Thomas Kornblit , Lone Smidstrups Friis , Ida Schiødt , Soeren Lykke Petersen , Niels Smedegaard Andersen , Henrik Sengeloev
Andreas A Rostved , Jens D Lundgren , Jens Hillingsø , Lars Peters , Amanda Mocroft , Allan Rasmussen
Andreas Søborg, Joanne Reekie , Allan Rasmussen , Caspar Da Cunha-Bang , Finn Gustafsson , Kasper Rossing , Michael Perch , Paul S. Krohn , Søren S. Sørensen , Thomas K. Lund , Vibeke R. Sørensen , Christina Ekenberg , Louise Lundgren , Isabelle P. Lodding , Kasper S. Moestrup , Jens D. Lundgren, , Neval E. Wareham
Quenia Dos Santos , Mads Hornum , Cynthia Terrones-Campos , Cornelia Geisler Crone , Neval Ete Wareham , Andreas Soeborg , Allan Rasmussen , Finn Gustafsson , Michael Perch , Soeren Schwartz Soerensen , Jens Lundgren , Bo Feldt-Rasmussen , Joanne Reekie
Neval Ete Wareham , Caspar Da Cunha-Bang, Álvaro H Borges, Christina Ekenberg, Jan Gerstoft, Finn Gustafsson, Ditte Hansen, Carsten Heilmann, Marie Helleberg, Jens Hillingsø, Paul Suno Krohn, Isabelle Paula Lodding, Thomas Kromann Lund, Louise Lundgren, Amanda Mocroft, Michael Perch, Søren Lykke Petersen, Irma Petruskevicius, Allan Rasmussen, Kasper Rossing, Andreas A Rostved, Henrik Sengeløv, Vibeke Rømming Sørensen, Søren Schwartz Sørensen, Jens D Lundgren

A A Rostved , S R Ostrowski , L Peters , J D Lundgren , J Hillingsø , P I Johansson , A Rasmussen
Lars Klingen Gjaerde , Sisse Rye Ostrowski , Lia Minculescu , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv
Lars K Gjærde , Niels S Andersen , Lone S Friis , Brian Kornblit , Søren L Petersen , Ida Schjødt , Sisse R Ostrowski , Henrik Sengeløv
Lars Klingen Gjærde , Sisse Rye Ostrowski , Niels Smedegaard Andersen , Lone Smidstrup Friis , Brian Kornblit , Søren Lykke Petersen , Ida Schjødt , Henrik Sengeløv