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Commentary

Why should quality metrics be used for infectious disease assessment, management and follow up in solid organ transplantation?

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This article presents our viewpoint based on our combined experience in transplantation, transplant infectious disease complications and health-care-associated infection (HAI) tracking systems. Quality metrics for transplant infectious disease should allow us to track donor safety, perform vaccinations, control prophylaxis adherence rates, and monitor the rates of surgical-site infections (SSIs) and other infections. However, even with targeted screening using highly sensitive pre-transplantation tests, adequate vaccination and prophylaxis, there may be some gaps in the process that can impact the outcomes. Transplant programmes should pay close attention to and document prophylaxis failures, HAI rates, rehospitalizations and excessive immunosuppression. With this in mind, we chose 16 indicators that we believe would demonstrate the quality of the transplant programme in each phase of the process, which may impact the infection risk.

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Transplantation is the only solution or the treatment of choice for some types of end-stage organ failure. However, transplantation is not without risks related to the procedure itself and due to immunosuppression. In addition, there are several bottlenecks associated with care, including the lack of appropriate access and premature transplant failure, which can lead to reduced quality of life and even death [1].

The quality of the transplant programme is a relevant topic of interest for both the health-care system and the transplant candidate. From the perspective of the patient, having access to this information could influence their choices regarding transplant care. Facilities use indicators to measure performance. The use of these metrics allows us to monitor, analyse and optimize health-care processes to increase quality. In the field of transplantation, these metrics are related to access, safety and effectiveness [1–3].

Since the mid-2000s, efforts have been made to track the outcomes and determine whether a transplant programme is delivering high-quality service. Globally, the key metrics for determining the quality of a transplant programme are related to patient survival and graft survival rates, and both can be reduced in the presence of infections [1].

In the United States of America (USA), mandatory reporting of survival data by all transplant hospitals has been instituted. The quality monitoring of graft and patient survival through biannual Scientific Registry of Transplant Recipients programme-specific reports in 2001 allowed improvements in both long-term and short-term outcomes. Therefore, since 2007, Medicare Programme Transplant Centers have been required to develop, implement and maintain a comprehensive, written, data-driven quality assessment and performance improvement programme designed to monitor and evaluate the performance of all transplantation services throughout the country. In 2013, the programme was expanded, and improvements were made [1].

In Europe, the Council of Europe Committee of Experts on the Organisational Aspects of Cooperation in Organ Transplantation was created at the end of the 1980s. In 2007, the activities related to transplantation were transferred to the European Directorate for the Quality of Medicines & Health Care. This move facilitated

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Table 1
Panel of indicators for transplant infectious disease assessment, management and follow up in transplant programmes

Time	Quality metrics	Definition	Calculation	Metric type	Quality domain
Pre-transplant	Infected donor	% of donor blood cultures traced by transplant team	No. of blood culture results obtained × 100/Total number of donors	Process	Safety
	Latent tuberculosis	% of waiting list patients assessed with TSTs or IGRAs	No. of patients tested with TSTs or IGRAs × 100/Total number waiting list patients	Process	Safety
	Vaccination of transplant candidate with live virus vaccine	% of wailist transplant candidates negative for measles and varicella vaccinated OR transplant candidates vaccinated for YF	No. of transplant candidates negative for measles and varicella or yellow fever who were vaccinated × 100/Total number of transplant candidates in the period	Process	Safety
Transplantation and early hospitalization	Discontinuation of SAP	% of patients in whom SAP is discontinued within 24 hours after surgery or according to protocol	No. of patients with SAP discontinued within 24 hours of surgery or according to protocol x 100/Total number of patients receiving SAP after surgery	Process	Safety
	Surgical-site infection	Surgical-site infection rates (CDC-NHSN criteria*)	No. of patients with surgical-site infections × 100/Total number of surgeries performed	Result	Safety
	7-day course of antimicrobials if donor was bacteraemic	% of patients receiving a post-transplant with 7-day course of antimicrobial if donor was bacteraemic	No. of patients who received a 7-day antimicrobial course after transplantation with an organ from bacteraemic donor × 100/ Total number of patients transplanted with an organ from bacteraemic donor	Process	Safety
	Length of stay	Number of days in the hospital from day of admission to the day of discharge after transplantation, with each stay past midnight counting as a hospital day. First hospitalization	Median length of hospital stay	Result	Effectiveness
	ICU length of stay	Number of days in the ICU after transplantation	Median length of ICU stay	Result	Effectiveness
Post-transplant care and outcome	Annual influenza vaccine	% of transplant patients who received an annual quadrivalent influenza vaccine	No. of transplant patients who received annual quadrivalent influenza vaccine × 100/Total number of transplanted patients	Process	Safety
	30-day mortality	% of transplant patients who die within the first 30 days post-transplant, including patients who died during the operation (operating theatre, ICU and hospital ward)	No. of patient deaths in the first 30 days post-transplant × 100/ Total number of transplant patients in the same period	Result	Safety
	Readmission in 7 and 30 days	% of patients readmitted within 7 and 30 days of initial discharge post-transplantation	No. of transplant patients readmitted at 7 and 30 days post-transplant/Total number of transplant patients in the period	Result	Safety
	Unplanned return to the operating room	% of transplant patients who require an unplanned second operation in the 15 or 30 days following the surgery, due to a complication with the primary surgery (does not include pre-arranged reoperations, procedures not related to a clinical complication, standard care reoperations; patients with multiple returns to the operating room are counted only once)	No. of transplant patients requiring an unplanned second operation 15 or 30 days after surgery × 100/Total number of transplant patients	Process	Safety
	Patient 1-year survival	No. of transplant patients alive at 1 year post-transplant (all deaths not related to the transplant are considered)	Kaplan–Meier survival statistical analysis	Result	Effectiveness
	Bacteraemia	% of patients with bacteraemia (Primary bloodstream infection - BSI) at 7 days or 30 days post-transplant (CDC-NHSN criteria*)	No. of patients with bacteraemia at 7 days or 30 days post-transplant × 100/ Total number of transplant patients	Result	Safety
	CDI	% of transplant patients with *Clostridioides difficile* infection (CDI) 30 days post-transplant (CDC-NHSN criteria*)	No. of patients with CDIs at 30 days post-transplant × 100/ Total number of transplant patients	Result	Safety
Programme	Transplant centre volume	No. of transplants performed	No. of transplants performed per month or year	Structure	Access

* https://cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf accessed January, 2020.
Abbreviations: BSI, Primary bloodstream infection; CDI, *Clostridioides difficile* infection; HAI, health-care-associated infection; ICU, intensive care unit; IGRA, interferon-γ release assay; NHSN/CDC, National Healthcare Safety Network/Centers for Disease Control; SAP, surgical antimicrobial prophylaxis; TST, tuberculin skin test.

collaboration with the European Union and was intended, among other objectives, to enable the transfer of knowledge and expertise among member states and organizations [2].

In general, these quality programmes evaluate metrics related to the transplant centre volume, lengths of hospital and intensive care unit stays, 30-day mortality, 1-year survival, readmission and unplanned return to the operating room; these metrics evaluate performance throughout the system. To evaluate these metrics, many methods and tools have been described. Recently, a Canadian systematic review identified and characterized more than 300 quality metrics used to assess quality and safety in solid organ transplant (SOT) programmes [1,3].

Infections represent a major cause of morbidity and mortality in candidates and transplant recipients. Furthermore, risk factors that predispose patients to infections can be categorized as being present before transplant (in the recipient or donor), developing due to intraoperative conditions and/or developing due to post-transplant events.

Risk-level classification regarding donor-derived infection transmission involves the use of a grading system to rank recommendations, resulting in classifications that vary from a standard risk to an unacceptable risk [4,5]. Whereas the classification of disease transmission according to risk levels may be helpful as a tool, each donor and recipient combination must be assessed individually based on their respective risk of infection [2]. The identification of infections in donors remains challenging and limited by the availability and performance of current donor epidemiological screening tools (e.g. questionnaires) and laboratory tests, and may be affected by the administration of prophylaxis/pre-emptive treatment. Although there is only a low rate of donor-to-recipient transmission, significant morbidity and mortality may result when it occurs, especially when infections are due to multidrug-resistant organisms (MDROs); such infections commonly result in prolonged hospitalization [2,6,7]. Taking into consideration the importance of donor-derived infections, we have chosen to track bacteraemic donors because the use of organs from such donors is related to early infectious complications. It is worth taking note as a post-transplant metric the administration of at least 7 days of antimicrobial therapy in the SOT recipient in cases in which the donor is considered to be infected.

Another very important strategy for disease prevention is vaccination. Immunization history is invaluable in the workup of potential recipients. Although immunization decreases the rates of vaccine-preventable diseases, vaccination rates have remained suboptimal, leaving transplant patients at increased risk for these illnesses [8]. It has been proposed that the rates of vaccination, specifically those for the pneumococcal vaccines, the quadrivalent influenza vaccine and, in some special cases, vaccines against re-emerging infections (e.g. yellow fever, measles), could be used as a quality metric. Vaccination issues should be evaluated in the pre-transplant (live virus vaccination) and post-transplant (annual influenza vaccination) periods.

Screening for latent tuberculosis infection using the tuberculin skin test or interferon-γ release assays in SOT candidates is a metric for evaluating pre-transplant exposure and can optimize the management of the risk of tuberculosis reactivation in patients in the post-transplant period [9].

Concerning the intraoperative risk factors, the choice of surgical reconstruction and unexpected events occurring during surgery might expose the recipient to a higher risk of infection. Injury to nerves or vessels and ischaemic injury to the allograft during the transplant procedure reduce graft viability and simultaneously increase the risk of complications. Likewise, a prolonged operation time, contamination of the operative field, and bleeding at or near the surgical site are also risk factors [6,10]. In general, these events are related to HAIs, mainly surgical infections.

In the first months after transplantation, the most prevalent infections are HAIs. Therefore, the National Healthcare Safety Network/CDC methodology includes four modules that focus on events associated with medical devices and surgical procedures in the *Patient Safety Component* (National Healthcare Safety Network/CDC www.cdc.gov). By focusing on these rates, it is possible to improve patient care.

Essential information regarding the rates of SSIs and appropriate surgical prophylaxis is needed. Antimicrobial prophylaxis is the standard of care for nearly all surgical procedures and is routinely prescribed during SOT, with the purpose of minimizing post-operative SSIs. Depending on the organ transplanted, SSIs occur in up to 50% of patients. Another concern, as previously mentioned, is the increased risk of developing SSIs caused by MDROs. Nevertheless, the impact of antimicrobial surgical prophylaxis targeted at MDRO colonization or infection or when the patient is at a high risk for MDROs is undoubtedly still very controversial [10]. This panel notes some indicators related to surgical antimicrobial prophylaxis and the SSI rate that should be useful.

As a result of antimicrobial use, *Clostridioides difficile* infection and infections caused by MDROs disproportionately affect SOT recipients and are associated with poor patient outcomes [6,7]. Notably, mortality associated with MDRO infections has increased, probably as a result of delayed recognition and therapy. Hence, the use of antimicrobial stewardship programme metrics can also provide guidance regarding best practices. We selected early (7 days) and late (30 days) SOT recipient bacteraemia and the *C. difficile* infection rate (<30 days after transplant) as indicators of infection control issues, considering bloodstream infections and the *C. difficile* infection index based on the National Healthcare Safety Network/CDC criteria.

In conclusion, in our view, this panel of metrics (Table 1) is a baseline that can serve as a foundation on which to build an infectious disease quality and safety programme. A few indicators for each step of the process (before, during and after transplantation) should be selected, monitored and improved.

The indicators are simple and probably already being used in other situations. The application of these indicators to SOT will enable the critical evaluation of the process. Furthermore, these metrics need to be prospectively tested in different scenarios to prove their usefulness.

Transparency declaration

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Author contributions

WTC and JC contributed equally to this work. Both contributed in the conception and design of the proposal, drafting the article and critical revision. All authors approved the final version for publication.

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