DOI: 10.12923/pielxxiw-2025-0039

Maastricht criteria III in the global context: a systematic review of development and implementation

Kryteria z Maastricht III w kontekście globalnym: systematyczny przegląd rozwoju i wdrażania

Jana Křivková[1,2,A-B,D-G], Jiří Šimek[1,A-B,F-G], Alena Lochmannová[3,B,D-G,K], Pavel Leden[2,A,G]

[1]Faculty of Health and Social Sciences, University of South Bohemia, Czech Republic
[2]Faculty of Health Care Studies, University of West Bohemia, Czech Republic
[3]Faculty of Medicine in Pilsen, Charles University, Czech Republic

CORRESPONDING AUTHOR:
Jana Křivková
Faculty of Health and Social Sciences, University of South Bohemia, České Budějovice, Czech Republic
e-mail: krivkova@fzs.zcu.cz
tel: +420 377 633 780

A – Development of the concept and methodology of the study/Opracowanie koncepcji i metodologii badań; B – Query - a review and analysis of the literature/Kwerenda – przegląd i analiza literatury przedmiotu; C – Submission of the application to the appropriate Bioethics Committee/Złożenie wniosku do właściwej Komisji Biotycznej; D – Collection of research material/Gromadzenie materiału badawczego; E – Analysis of the research material/Analiza materiału badawczego; F – Preparation of draft version of manuscript/Przygotowanie roboczej wersji artykułu; G – Critical analysis of manuscript draft version/Analiza krytyczna roboczej wersji artykułu; H – Statistical analysis of the research material/Analiza statystyczna materiału badawczego; I – Interpretation of the performed statistical analysis/Interpretacja dokonanej analizy statystycznej; K – Technical preparation of manuscript in accordance with the journal regulations/Opracowanie techniczne artykułu zgodne z regulaminem czasopisma; L – Supervision of the research and preparation of the manuscript/Nadzór nad przebiegiem badań i przygotowaniem artykułu

STRESZCZENIE

KRYTERIA Z MAASTRICHT III W KONTEKŚCIE GLOBALNYM: SYSTEMATYCZNY PRZEGLĄD ROZWOJU I WDRAŻANIA

Cel pracy. Niniejszy przegląd analizuje rozwój i wdrożenie Kryteriów Maastricht III w kontrolowanym (cDCD) i niekontrolowanym (uDCD) dawstwie po zgonie krążeniowo-oddechowym w różnych systemach opieki zdrowotnej, ocenia przestrzeganie okresu „no-touch" oraz bada wpływ modeli zgody opt-in i opt-out na dostępność i wykorzystanie dawców.

Materiał i metody. Zgodnie z zasadami praktyki opartej na dowodach przeprowadzono systematyczne wyszukiwanie w pełnotekstowych bazach elektronicznych z zakresu ochrony zdrowia, bioetyki i nauk transplantacyjnych. Uwzględniono recenzowane artykuły w pełnym tekście, dotyczące klasyfikacji i zastosowań klinicznych DCD. Ponadto przeprowadziliśmy krytyczną ocenę jakości metodologicznej wszystkich włączonych badań z wykorzystaniem standaryzowanego narzędzia, aby wzmocnić wiarygodność wniosków.

Wyniki. Jedenaście badań spełniło kryteria włączenia, obejmując klasyfikację DCD, ramy prawne dotyczące zgody, przestrzeganie okresu „no-touch" i wpływ na pobieranie narządów. Zaobserwowano znaczne zróżnicowanie międzynarodowe: systemy z domniemaną zgodą (opt-out) osiągały wyższe wskaźniki konwersji dawców, podczas gdy wydłużenie okresu „no-touch" negatywnie wpływało na żywotność narządów.

Wnioski. Przegląd przedstawia uporządkowaną analizę zastosowania Kryteriów Maastricht III, zwłaszcza w Europie. cDCD jest realizowane według coraz bardziej ujednoliconych protokołów, podczas gdy uDCD pozostaje wdrażane nierównomiernie z powodu wyzwań etycznych i logistycznych. Aby poprawić identyfikację dawców, wykorzystanie narządów i wyniki transplantacji, kluczowe jest ujednolicenie protokołów, udoskonalenie technik ograniczania niedokrwienia oraz wzmocnienie współpracy międzynarodowej.

Słowa kluczowe: pielęgniarstwo, etyka, zatrzymanie akcji serca, pobieranie tkanek i narządów, przeglądy systematyczne

ABSTRACT

MAASTRICHT CRITERIA III IN THE GLOBAL CONTEXT: A SYSTEMATIC REVIEW OF DEVELOPMENT AND IMPLEMENTATION

Aim. This review examines the development and implementation of the Maastricht Criteria III in controlled (cDCD) and uncontrolled (uDCD) Donation after Circulatory Death in various healthcare systems, evaluates compliance with the no-touch interval, and the influence of opt-in versus opt-out consent models on the availability and use of donor organs.

Material and methods. Following Evidence-Based Practice principles, a systematic search was performed in full-text electronic databases covering healthcare, bioethics, and transplantation sciences. Peer-reviewed, full-text studies relevant to DCD classification and clinical application were included. Additionally, a critical methodological quality appraisal of all included studies was conducted using a standardised tool, thereby enhancing the robustness of our conclusions.

Results. Eleven studies met inclusion criteria, addressing DCD classification, consent frameworks, no-touch interval adherence, and organ procurement impact. Substantial international variability emerged: presumed consent (opt-out) systems achieved higher donor conversion rates, whereas extended no-touch intervals detrimentally affected organ viability.

Conclusions. This review presents a structured analysis of Maastricht Criteria III application, particularly in Europe. cDCD follows increasingly standardised protocols, while uDCD remains inconsistently implemented due to ethical and logistical challenges. To enhance donor identification, organ utilisation, and transplantation outcomes, it is essential to standardise protocols, refine ischemia-mitigation techniques, and strengthen international collaboration.

Key words: nursing, ethics, heart arrest, tissue and organ procurement, systematic reviews

INTRODUCTION

The persistent shortage of donor organs has necessitated the development of structured, ethically sound protocols to expand the donor pool and improve transplant availability. The gap between organ supply and demand remains a major societal challenge, highlighting the need to promote donation and optimize transplantation [1,2].

One key advancement is the Maastricht Classification for donation after circulatory death (DCD), introduced by Professor Kootstra in 1990. It standardised identification and management of donors after circulatory arrest while ensuring ethical and legal integrity [3]. This framework responded to organ shortages, as a primary barrier causing long waiting lists and increased mortality.

To expand donors, some programs have used extended criteria donors, though this increases organ discard due to poorer graft function [4]. Another strategy is uncontrolled DCD (uDCD), but implementation and outcomes vary across health systems, requiring more research [1,5].

Kootstra et al. emphasised the importance of well-defined guidelines for non-heart-beating donors (NHBDs), leading to the Maastricht Protocol introduced at the 1995 International Workshop [3,6-8]. This protocol classifies donors by circulatory arrest circumstances [9] and distinguished controlled vs uncontrolled DCD for consistent donor management [3,10].

A fundamental element is the „non-touch interval," a 10-minute period post-death declaration without interventions to confirm irreversibility before retrieval. Its duration varies internationally, dictated by national medical and legal frameworks [8,11].

With advances in transplantation, the Maastricht Classification has evolved based on evidence-based medicine. Some countries integrated it into law, others apply it via medical consensus [12]. The Czech Republic follows a regulated approach, incorporating the Maastricht criteria into national guidelines endorsed by key professional societies [13]. In 2000, the Czech Republic added Category V to the Maastricht Criteria, covering unexpected cardiac arrest in hospitalised patients [14], reflecting classification evolution [9]. Distinguishing circulatory from brain death is essential. Categories I, II, and IV apply when brain death can be confirmed: I covers patients dead on arrival without resuscitation; II includes unsuccessful resuscitations; IV involves cardiac arrest following brain death [3,9].

This review focuses on Maastricht Category III (controlled/uncontrolled DCD) [15], involving patients expected to die after withdrawal of life-sustaining therapy (WLST). These cases occur mainly in intensive care units, with consensus between clinicians and families on treatment futility [11]. Unlike brain-dead donors, Category III donors experience circulatory death without full neurological brain death criteria, often due to irreversible, non-survivable conditions leading to planned transition to palliative care with family consent [16]. Given the significance of this issue, this review critically evaluates the Maastricht Criteria III development and implementation worldwide, examining clinical practices, ethics, regulations, and consent models to identify challenges and best practices guiding future protocol standardization.

MATERIALS AND METHODS

Data sources and search strategies

This study was conducted in accordance with the principles of Evidence-Based Practice [17] to ensure methodological rigor and validity in the search process. To clarify the scope and focus of this review, the modified PICo framework was applied, which includes three main components: Population (donors after circulatory death), Interest (the development and implementation of the Maastricht Criteria III in controlled and uncontrolled settings), and Context (selected countries with opting-in or opting-out organ donation systems). These components are summarised in Table 1. Based on this framework, the research question was defined as follows: How do differences in national consent systems and clinical practices influence the development, implementation, and utilisation of Maastricht Criteria III in controlled and uncontrolled Donation after Circulatory Death (DCD)?

Tab. 1. The "PICo" mnemonic, search terms, and inclusion criteria

Inclusion Criteria	Participants	Phenomena of Interest	Context
Eligibility Criteria	Studies include organ donors after circulatory death (DCD) within the Maastricht III framework (controlled and uncontrolled). They address legal frameworks, ethical issues, and clinical applications.	Experiences and procedures implementing Maastricht III in various countries, impact of opt-in and opt-out systems on compliance and donor numbers, and adherence to the no-touch interval with its clinical implications.	Studies examine healthcare systems, legal and ethical DCD approaches, and Maastricht III implementation in controlled and uncontrolled settings, including countries with opt-in and opt-out systems.
Keywords	'Maastricht III', 'Donation after Circulatory Death (DCD)', 'controlled DCD', 'uncontrolled DCD'	'opt-in organ donation', 'opt-out organ donation', 'no-touch interval', 'organ transplantation policies'	'ethical considerations in DCD', 'healthcare policies in transplantation'

A systematic search was performed in full-text databases focused on healthcare, ethics, and transplantation: ProQuest STM + Hospital Collection – Medline, Web of Science, PubMed, Scopus, and Google Scholar. Boolean operators combined keywords from the modified PICo framework. No wildcards or acronyms were used as keywords were comprehensive. Articles were first screened by title and abstract; relevant studies underwent full-text analysis. The exact search strings and Boolean operators used in each database are detailed in Tab. 2.

Tab. 2. Search strings and Boolean operators used in electronic databases

Database	Search string	Notes
ProQuest STM + Medline	("Maastricht III" OR "Donation after Circulatory Death" OR "DCD") AND ("opt-in" OR "opt-out") AND ("no-touch interval" OR "protocol")	Exact phrases in quotes; no truncation
Web of Science	("Maastricht III" OR "Donation after Circulatory Death") AND ("opt-in" OR "opt-out") AND ("no-touch interval" OR "protocol")	Exact phrases in quotes; no truncation
PubMed	("Maastricht III" OR "Donation after Circulatory Death") AND ("opt-in" OR "opt-out") AND ("no-touch interval" OR "protocol")	Exact phrases in quotes; no truncation
Scopus	("Maastricht III" OR "Donation after Circulatory Death") AND ("opt-in" OR "opt-out") AND ("no-touch interval" OR "protocol")	Exact phrases in quotes; no truncation
Google Scholar	"Maastricht III" "Donation after Circulatory Death" "opt-in" "opt-out" "no-touch interval"	Keywords combined without Boolean logic

Eligibility criteria

Studies were included based on eligibility criteria: full-text availability, peer-reviewed publication, English language, and publication between the years 1995 and 2024. The selection aimed to capture the evolution and implementation of the Maastricht Criteria III with methodological rigor. Studies on ethical aspects of DCD and DBD, dead donor rule, death criteria, and circulatory death assessment were included for context. The initial search found 519 publications. After removing 218 duplicates, 80 records were screened by title and abstract. Fifty-nine were excluded due to irrelevance or failure to meet the inclusion criteria. Twenty-one full-text reports were assessed for eligibility. Of these, 10 were excluded: 8 due to missing essential data and 2 due to lack of relevance to the research question. Eleven studies were selected for final inclusion, balancing comprehensiveness with feasibility. Selection was based on thematic saturation, methodological rigor, and availability of relevant data. The PRISMA flow diagram (Fig. 1) illustrates the selection process.

Data analysis

The selected studies were analysed using content analysis, a qualitative method for systematically categorising data relevant to the research question. The process included initial skimming, followed by detailed reading and coding. Studies were categorised on the basis of the modified PICo framework, focusing on participants (DCD donors), phenomena (development and implementation of the Maastricht III in controlled/uncontrolled settings), and context (countries with opt-in or opt-out systems). This enabled structured comparison of regulatory impacts on DCD donor rates.

All four authors independently reviewed full texts, focusing on the introduction, methods, discussion, and conclusions. Data were coded by categories: country, opt-in/opt-out system, the Maastricht III type (controlled/uncontrolled), no-touch interval adherence, and impact on DCD donor numbers. Thematic patterns emerged through iterative coding, grouping findings on regional policy differences, no-touch compliance, and regulatory effects on donation. Discrepancies were resolved by discussion to reach consensus. This process reflects a qualitative content analysis approach, which involves systematic coding and theme identification to ensure a rigorous and transparent interpretation of qualitative data [18].

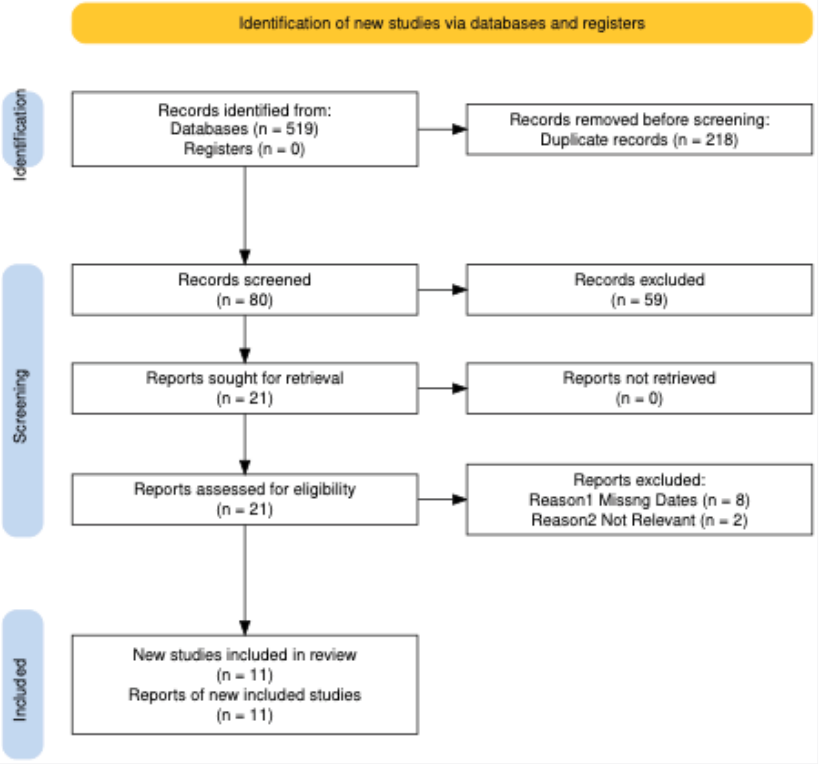

Fig 1. PRISMA flow diagram

The Boolean search strategy guided the analytical framework, mapping extracted data to key search terms to align analysis with search parameters. A standardised data extraction form ensured methodological consistency. No specialised software was used; manual categorisation enabled focused, context-rich interpretation. The final synthesis highlights key variations in Maastricht III implementation and their impact on DCD donor rates across regulatory systems.

Quality appraisal

To ensure the reliability and robustness of this systematic review, we performed a quality appraisal using the Quality Assessment with Diverse Studies (QuADS) tool, which was selected because its evidence base combines qualitative, quantitative and mixed-methods designs and QuADS has shown substantial inter-rater reliability as well as confirmed

Tab. 3. Item-level QuADS methodological quality scores for the 11 included studies (0 = criterion not met; 3 = fully met)

Study	Clear aims	Theory / Background	Context	Sampling strategy	Data collection	Analytical rigor	Reflexivity	Ethics	Validity/ Reliability	Integration of findings	Interpretation	Limitations	Implications	Total
Kootstra 1995 [3]	2	2	1	1	1	1	0	1	1	1	1	1	0	13
Shemie 2006 [20]	3	3	3	3	3	3	2	3	3	3	2	3	2	36
Graftieaux 2012 [21]	3	3	2	2	2	2	1	2	1	1	2	2	1	24
Evrard 2014 [22]	3	3	2	2	2	2	1	2	2	2	2	2	1	26
Kenmochi 2014 [23]	3	3	2	2	2	2	2	2	2	2	2	2	2	28
Thuong 2016 [9]	3	3	3	3	3	3	2	3	3	3	2	3	2	36
Domínguez-Gil 2016 [24]	3	3	3	2	2	3	2	3	3	3	2	3	2	34
Giannini 2016 [25]	3	3	2	2	2	2	1	2	2	2	2	2	2	27
Hodgson 2017 [26]	3	3	3	3	3	3	2	3	3	3	2	3	2	36
Lomero 2020 [27]	3	3	3	3	3	3	2	3	3	3	2	3	2	36
Lepoittevin 2022 [28]	3	3	2	2	2	2	1	2	2	2	2	2	1	26

Note: QuADS = Quality Assessment with Diverse Studies tool. Each of the 13 items is scored 0 = not addressed, 1 = partly addressed, 2 = mostly addressed, 3 = fully addressed (maximum study total = 39). Column headings correspond to the full QuADS wording as follows: Clear aims (Q1) = statement of research aims; Theory / Background (Q2) = theoretical or conceptual underpinning to the research; Context (Q3) = description of research setting and target population; Sampling strategy (Q4) = appropriateness of sampling strategy to address the research aims; Data collection (Q5) = rationale for and description of data-collection methods/ tools; Analytical rigor (Q6) = justification and appropriateness of the analytical approach; Reflexivity (Q7) = consideration of researcher or stakeholder influence; Ethics (Q8) = evidence of ethical approval and participant consent; Validity / Reliability (Q9) = strategies to enhance reliability, validity or trustworthiness; Integration of findings (Q10) = coherence of findings across data sources; Interpretation (Q11) = depth and interpretive insight of the analysis; Limitations (Q12) = critical discussion of study strengths and limitations; Implications (Q13) = relevance, transferability and implications for practice or further research. The "Total" column sums these items (range 0–39), with higher scores indicating stronger methodological quality.

face and content validity in heterogeneous health-services research [19]. Two reviewers independently scored each study on the 13 official QuADS items, using the prescribed 0-3 scale, and any disagreements were resolved by consensus. For clarity and space, the column headings in Tab. 3 use shortened labels (e.g., Clear aims, Sampling strategy), but they match one-to-one onto the full QuADS wording; the complete wording is provided in the table legend. Item-level scores for every study are presented in Tab. 3, making the appraisal process fully transparent. Most studies achieved moderate to high overall quality, although limitations such as sample-size variability and differing definitions of key concepts (e.g., the no-touch interval) were noted. Overall, the appraisal supports the credibility of our conclusions and highlights areas where future research could further strengthen methodological rigour.

RESULTS

Eleven studies meeting eligibility criteria were included, focusing on the Maastricht Criteria III implementation worldwide (Tab. 4). Studies came from Belgium, Canada, France, Italy, Japan, the UK, and other European countries, covering legal, ethical, clinical, and outcome aspects of DCD. Results were categorised into four themes: 1) Maastricht criteria III adoption, 2) opt-in vs. opt-out systems, 3) controlled vs. uncontrolled DCD, and 4) no-touch interval and clinical implications.

Adoption of Maastricht Criteria III

The Maastricht classification by Kootstra et al. established the foundation for DCD categorisation [3]. Its implementation varies by jurisdiction due to differing laws and ethics. Evrard et al. analysed Belgian adoption with a proposed modified classification that includes euthanasia-associated donation as Category V, unique to Belgium and reflecting national ethics [22].

Graftieaux et al. studied the French approach to Maastricht III (MC III), stressing strict adherence to the dead donor rule and ethical challenges around WLST and donor families [21]. Lepoittevin et al. highlighted the growing use of normothermic regional perfusion (NRP) to improve organ viability, now mandatory for abdominal retrieval in France [28]. Thuong et al. called for international standardisation of MC III through harmonised definitions to improve outcomes [9]. Lomero et al. noted wide variability in implementation across Europe, with the highest adoption levels in the UK, Spain, Belgium, and France [27]. Domínguez-Gil et al. emphasised ongoing inconsistencies, especially in ante-mortem interventions and ischemia time definitions [24]. Kenmochi et al. reported that despite Japan's 2010 legislative reforms, donor numbers remained low. Out of the 247 donors (242 DCD, 5 DBD), most of them were Maastricht II cases, as controlled DCD is rarely used. Societal reluctance towards brain death criteria hinders program expansion. The study stressed the need for greater public awareness and family discussions to improve DCD acceptance [23].

Tab. 4. Overview of Included Studies

Study (Author – Year – Country)	Concise Summary (design, focus, key findings)
Kootstra 1995 – Netherlands [3]	Classification paper introducing four NHBD categories based on cardiac-arrest scenarios; proposes structured donor identification and rapid cooling to optimize organ viability. The original Maastricht framework standardized DCD practice, improved graft success, and became the foundation for subsequent global policies.
Shemie 2006 – Canada [20]	National policy review charts Canada's Maastricht III rollout: structured donation after planned WLST with a 5-min no-touch period, while uncontrolled DCD stays rare amid logistical hurdles. Opt-in consent, regional disparities and weak ICU–transplant coordination curb donor numbers; authors call for uniform rules, tighter teamwork and broader education.
Graftieaux 2012 – France [21]	Ethical-policy paper for France's Maastricht III rollout: organ retrieval only after planned WLST, strictly separated from that decision, in line with Léonetti law; 5-min no-touch upheld. Stresses dead-donor rule, clear family communication, robust ICU–transplant coordination, and nationwide public education to ensure ethical integrity.
Evrard 2014 – Belgium [22]	Belgian policy review refines Maastricht classification: expert consensus adds Category V (euthanasia) and distinguishes controlled (III–V) from uncontrolled (I–II) donors. Opt-out legislation boosts donor rates; paper stresses warm-ischemia limits, ethical transparency, and urges standardized ischemic and no-touch definitions plus global harmonization.
Kenmochi 2014 – Japan [23]	Retrospective single-center review (Fujita Health University Hospital, 2008–2012) of 247 donors showed DCD dominance (242 vs 5 DBD). After the 2010 law, family discussions rose but donations fell; cultural resistance to brain death, opt-in consent, and logistical delays limited controlled MC-III uptake and reduced organ viability.
Thuong 2016 – Europe (consensus) [9]	Consensus paper from the 6th International DCD Conference (2013) standardizes Maastricht terminology: expert group distinguishes controlled (III, planned WLST) from uncontrolled pathways, aligns ischemia thresholds and intervention points, notes 2–20 min no-touch (most 5 min), and urges global harmonization of definitions, donor eligibility, and consent policies to boost DCD recruitment.
Domínguez-Gil 2016 – Spain/France/NL [24]	European review of established uDCD programmes finds wide legal/ethical variation; prolonged warm ischemia complicates viability, demanding rapid EMS/ICU coordination and consistent death determination. Opt-out nations (Spain, France) convert more donors; authors urge harmonized protocols, standard ischemia limits and 5-min no-touch, plus public outreach.
Giannini 2016 – Italy [25]	Italian policy-ethical review highlights cultural/legal hurdles limiting controlled DCD: opt-in consent and 20-min no-touch interval undermine viability, so uDCD (Alba ECMO programme) is prioritized. Authors urge national strategy—legal reform, shorter interval, stronger ICU-transplant coordination and public education—to expand donation.
Hodgson 2017 – United Kingdom [26]	UK registry review (2004–2014) found controlled DCD donors rose 292 % post-2008 reforms, yet organs per donor fell as many never reached circulatory deaths. Uncontrolled DCD stayed rare; opt-in consent, ICU-protocol variability, referral delays and a 3-hour no-touch window hampers retrieval, so authors urge streamlined referrals, tighter ICU–transplant coordination and strategies to convert DCD to DBD donors.
Lomero 2020 – 35 EU states [27]	Pan-European survey (35 Council of Europe states, 2008–2016) shows controlled DCD is widespread and structured, whereas uncontrolled remains limited by warm-ischemia injury. Maastricht III criteria, ischemia limits and ante-mortem practices vary markedly; no-touch intervals span 5–30 min (most 5). Opt-out nations (Spain, Belgium) achieve higher donor rates. Authors call for unified protocols, standardized ischemia definitions and policy harmonization to boost donor identification and organ viability.
Lepoittevin 2022 – France [28]	French national review links transplant data with policy: controlled DCD via planned WLST is expanding, whereas uncontrolled is logistics limited. Mandatory NRP for abdominal grafts plus hypo/normothermic perfusion improve viability; 5-min no-touch retained. Authors urge standardized ischemia limits, broader NRP, better donor ID, public outreach and ICU–transplant training.

Implementation of Opting-in and Opting-out Systems

The regulatory framework significantly impacts the DCD availability. Hodgson et al. examined the UK's shift to an opt-out system, noting a 292% increase in DCD donors (from 1,187 to 4,652) between 2004 and 2014. While registration improved, the number of non-utilised donors also grew, indicating the need to refine retrieval protocols [26]. The opt-in model in Canada, as noted by Shemie et al., is linked to lower DCD availability compared to opt-out countries [20]. Giannini et al. found similar barriers in Italy, where opt-in laws hinder uncontrolled DCD integration [25]. Lomero et al. observed that opt--out countries like Spain, Belgium, and France have higher DCD rates, suggesting presumed consent supports broader donor identification [27]. Kenmochi et al. reported that Japanese opting-in system, combined with cultural factors, limits donor recruitment. Despite more frequent donation discussions since the 2010 legal revisions, family refusal remains the main barrier to donor conversion [23].

Controlled vs. Uncontrolled DCD

The distinction between cDCD and uDCD is key to DCD implementation. Thuong et al. proposed a revised classification reflecting current practices [9]. Evrard et al. observed that cDCD is predominant in Belgium, while uDCD is rare due to stricter legal restrictions [22]. Domínguez-Gil et al. showed successful uDCD integration in Spain and France, supported by pre-hospital identification and rapid preservation [24]. In the UK, Hodgson et al. noted that most DCD retrievals occur within 30 minutes of WLST, aligning with viability best practices [26]. In Japan, Kenmochi et al. reported only 5 DBD donors out of 247 (2008-2012), with DCD as the main source. Cultural resistance to brain death and past controversies limit donation rates. Despite the 2010 law revision, donor increase was minimal, underscoring the need for public education. Most DCD cases are uncontrolled, often in emergency settings, leading to longer ischemia times and lower transplant success [23].

No-Touch Time Interval and its Clinical Implications

The no-touch interval between circulatory arrest and organ retrieval varies among countries. In the United Kingdom, most DCD donors proceed within 30 minutes of treatment withdrawal [26]. Lomero et al. reported that in Europe intervals range from 5 to 30 minutes, based on national protocols and ethics [27]. Shemie et al. examined recommendations from the American College of Critical Care Medicine, which advise a minimum 2-minute observation period. Their findings confirm that no cases

Tab. 5. Comparative Summary of the Four Thematic Areas in Maastricht Criteria III Implementation

Thematic Area	Adoption of Maastricht Criteria III	Implementation of Opt-in vs Opt-out Systems	Controlled (cDCD) vs Uncontrolled DCD (uDCD)	No-touch Interval and Clinical Implications
Geographic and Regulatory Context	Primarily European countries (Belgium, France, UK, etc.) with some reports from Japan and Canada. Belgium uniquely added Category V for euthanasia-related donation.	Countries with opt-out (presumed consent) systems (Spain, Belgium, France, UK) have higher donor rates than opt-in countries (Canada, Italy, Japan).	cDCD prevalent in structured healthcare settings (Europe, Canada); uDCD implementation inconsistent, limited by logistics and ischemic injury risks.	No-touch intervals vary internationally from 2 to 30 minutes; majority adopt 5 minutes; Italy enforces a notably longer 20-minute interval.
Key Ethical and Legal Challenges	Adaptations of Maastricht III to national laws and ethical standards; balancing end-of-life care with organ retrieval.	Opt-in systems require explicit consent, limiting donor pool; opt-out systems facilitate donation, but family refusals remain.	Ethical and logistical barriers hamper uDCD expansion; cDCD protocols more established, with WLST decision independent of donation.	Variation in no-touch interval reflects differing death determination criteria; prolonged intervals risk organ viability but ensure death irreversibility.
Impact on Donor Availability and Utilization	Adoption linked with improved standardization and donor identification in Europe; limited uptake in Japan due to cultural/legal constraints.	Opt-out countries show significantly increased DCD donor numbers; opt-in countries show lower rates and slower growth.	cDCD programs improve donor management and organ viability; uDCD offers expansion potential but requires rapid emergency response and extracorporeal techniques.	Shorter intervals support better graft function; longer intervals (e.g. Italy) reduce viable organ retrieval; normothermic regional perfusion (NRP) mitigates ischemic damage.
Recommendations and Innovations	Harmonization of Maastricht criteria; inclusion of new categories (e.g. euthanasia-related in Belgium); emphasis on clear protocols.	Enhance public and professional education; improve consent processes and ICU-transplant coordination	Increase coordination between emergency and transplant teams; adopt technologies (NRP, machine perfusion) to improve outcomes.	Standardize no-touch interval with ethical safeguards; integrate ischemia mitigation technologies; international collaboration encouraged.

of spontaneous autoresuscitation were reported beyond 2 minutes of circulatory arrest [20]. Giannini et al. described in Italy a 20-minute no-touch interval—among the longest in Europe, which hampers organ preservation and reduces viable DCD transplants [25]. Similarly, Kenmochi et al. noted the lack of a standardised interval in Japan, with prolonged delays further compromising the viability of organs [23]. Lepoittevin et al. highlighted normothermic regional perfusion (NRP) in France as a method to reduce ischemic damage during the no-touch interval, suggesting that such technologies could support practice standardisation across countries [28]. For clarity, the key findings across the four thematic areas are summarised in Tab. 5.

DISCUSSION

The systematic review findings highlight substantial variation in the implementation of MC III criteria across different healthcare systems [29-30]. Jurisdictions with clear end-of-life legislation have embraced controlled DCD (cDCD), whereas uncontrolled DCD (uDCD) remains inconsistent as a result of logistical and ethical hurdles [24,27]. Robust legal support has enabled Spain, Belgium and France to integrate MC III nationally [27], while Japan and Italy still face cultural, legal and infrastructural barriers [23,25]. Program viability hinges on the cDCD–uDCD division: with planned WLST therapy, cDCD protocols reduce warm ischaemia and protect grafts [9]; uDCD, triggered by unexpected heart arrest, demands ultra-rapid retrieval, reliable donor identification, strict pre-hospital coordination and supportive technologies such as normothermic regional perfusion to counter ischaemic injury [27,28].

The Maastricht III criteria vary widely at present [30]: each jurisdiction adjusts protocols to its legal–ethical context [9]. Belgium expanded the scheme with Category V for euthanasia-related donation [22,31], while France mandated normothermic regional perfusion to limit ischaemia and boost graft outcomes [28,32]. Persisting differences in regulatory interpretation keep MC III application uneven, underscoring the need for a shared international standard [27].

Legal frameworks strongly influence DCD success. Opt-in schemes in Canada and Italy, which need explicit consent, show lower donor conversions [20,25]. Opt-out systems in Spain, Belgium and the United Kingdom raise donor availability, though family refusals still occur [27]. The UK's transition to presumed consent illustrates how regulatory change boosts registrations and conversions [26]. Higher rates also depend on public education, clinician engagement and open family dialogue at end of life [26,33].

No-touch interval rules vary widely. The UK and France apply a 5-minute pause, balancing ethics and viability of the transplantation [21,28], whereas the 20-minute limit in Italy prolongs warm ischaemia and risks poorer outcomes [25]. This divergence reflects broader end-of-life criteria and complicates harmonisation [27]. New approaches – normothermic regional perfusion and machine perfusion – can offset ischaemic injury, so future MC III protocols should pair a standardised interval with these technologies [27,28].

Despite progress, MC III programmes still face inconsistent ischaemia management, uneven policy enforcement and unresolved end-of-life ethics, all of which constrain the DCD potential [20,27]. A multifaceted response is needed: standardisation of classification, refined preservation protocols and strengthened international evidence-based collaboration [28]. Public-awareness campaigns are also vital where cultural or religious views deter donation [23,34].

The future work should compare the long-term results of opt-in versus opt-out impacts [26], test new ischaemia-mitigation technologies [28] and develop better family-consent strategies [27] to optimise MC III procedures and transplant outcomes worldwide.

This review presents a global picture of Maastricht III implementation, yet comparability is limited by heterogeneous study designs, overrepresentation of high-capacity donation systems, and inconsistent terminology (e.g., no--touch interval). However, it delivers useful insights and pinpoints gaps for future research.

CONCLUSIONS

This systematic review examines the global implementation of the MC III, highlighting significant differences in donor classification, consent models, and adherence to the no-touch interval. Countries with opt-out systems generally achieve higher donor rates, whereas prolonged no-touch intervals in some jurisdictions negatively impact organ viability. Controlled donation after circulatory death is well established in structured healthcare systems, while uncontrolled DCD remains inconsistent due to logistical and ethical challenges.

Despite advancements in DCD protocols, challenges persist, including regulatory discrepancies, ethical concerns, and public perceptions. To enhance donor utilisation and transplantation success, future efforts should focus on standardising MC III criteria, optimising organ preservation strategies, and strengthening international collaboration in DCD practices.

ORCID

Jana Křivková https://orcid.org/0000-0002-0461-5251
Jiří Šimek https://orcid.org/0000-0002-6103-9959
Alena Lochmannová https://orcid.org/0000-0001-7822-0204
Pavel Leden https://orcid.org/0009-0000-1138-5178

REFERENCES

1. Rudge C, Matesanz R, Delmonico FL, et al. International practices of organ donation. Br. J. Anaesth. 2012;108: i48-55. https://doi.org/10.1093/bja/aer399
2. González-Méndez MI, López-Rodríguez L. Organ donation after controlled cardiac death under Maastricht category III: ethical implications and end-of-life care. Enferm. Clin. (Engl. Ed). 2019; 29(1): 39-46. https://doi.org/10.1016/j.enfcli.2017.10.009.
3. Kootstra G, Daemen JHC, Oomen AP. Categories of non-heart-beating donors. Transplant Proc. 1995; 27(5): 2893-2894.
4. Barreda Monteoliva P, Redondo-Pachón D, Minambres García E, Rodrigo Calabia E. Kidney transplant outcome of expanded criteria donors after circulatory death. Nefrologia. 2022; 42(2): 135-144.
5. Ortega-Deballon I, Hornby L, Shemie SD. Protocols for uncontrolled donation after circulatory death: a systematic review of international guidelines, practices and transplant outcomes. Crit Care. 2015; 19: 268. https://doi.org/10.1186/s13054-015-0985-6.
6. Kootstra G, van Heurn E. Non-heart-beating donation of kidneys for transplantation. Nat. Clin. Pract. Nephrol. 2007; 3(3): 154-163. https://doi.org/10.1038/ncpneph0426.
7. Daemen JWHC, Oomen APA, Janssen MA, et al. Glutathione S-transferase as predictor of functional outcome in transplantation of machine-preserved non-heart-beating donor kidneys. Transplantation. 1997; 63(1): 89-93. https://doi.org/10.1097/00007890-199701150-00017.
8. Daemen JWUC, de Wit AJ, Heineman E, et al. Kidney transplantation from non-heart-beating donors. Transplant. Rev. 1995; 9(4): 159-167. https://doi.org/10.1016/0955-470X(95)80001-0.
9. Thuong M, Ruiz A, Evrard P, et al. New classification of donation after circulatory death donors: definitions and terminology. Transpl. Int. 2016; 29(7): 749-759. https://doi.org/10.1111/tri.12776.
10. Manara AR, Murphy PG, O'Callaghan G. Donation after circulatory death. Br. J. Anaesth. 2012; 108: i108-i121. https://doi.org/10.1093/bja/aer357.
11. Massad E, Chaib E. Mathematical approaches to liver transplantation. Amsterdam: Elsevier; 2020, p. 192. https://doi.org/10.1016/C2018-0-02128-3.
12. Talbot D, D'Alessandro A. Organ donation and transplantation after cardiac death. Oxford: Oxford University Press; 2009, p. 335 https://doi.org/10.1093/med/9780199217335.001.0001.
13. Cvachovec K, Černý V, Duška F, et al. Doporučený postup před odběrem orgánů od zemřelých dárců po nevratné zástavě oběhu. Anesteziol. Intenziv. Med. 2014; 25(2): 145-146.
14. Detry O, Le Dinh H, Noterdaeme T, et al. Categories of donation after cardiocirculatory death. Transplant. Proc. 2012; 44(5): 1189-1195. https://doi.org/10.1016/j.transproceed.2012.05.001.
15. Kin T, Noguchi H, Kawaguchi A. Is donation after circulatory determination of death in Japan uncontrolled or controlled? OBM Transplant. 2024; 8(2): 1-12. https://doi.org/10.21926/obm.transplant.2402216.
16. Baláž P. Odběry orgánů k transplantaci. Prague: Karolinum Press; 2012, p. 259.
17. Stevens KR. Systematic reviews: the heart of evidence-based practice. AACN Adv. Crit. Care. 2001; 12(4): 529-538. https://doi.org/10.1097/00044067-200111000-00009.
18. Finfgeld-Connett D. Use of content analysis to conduct knowledge-building and theory-generating qualitative systematic reviews. Qual. Res. 2014; 14(3): 341-352. https://doi.org/10.1177/1468794113481790.
19. Harrison R, Jones B, Gardner P, et al. Quality assessment with diverse studies (QuADS): an appraisal tool for methodological and reporting quality in systematic reviews of mixed- or multi-method studies. BMC Health Serv. Res. 2021; 21: 144. https://doi.org/10.1186/s12913-021-06122-y.
20. Shemie SD, Baker AJ, Knoll G, et al. Donation after cardiocirculatory death in Canada. CMAJ. 2006; 175: S1-S24. https://doi.org/10.1503/cmaj.060895.
21. Graftieaux JP, Bollaert PE, Haddad L, et al. Contribution of the ethics committee of the French Intensive Care Society to describing a scenario for implementing organ donation after Maastricht type III cardiocirculatory death in France. Ann. Intensive Care. 2012; 2: 23. https://doi.org/10.1186/2110-5820-2-23.
22. Evrard P. Belgian modified classification of Maastricht for donors after circulatory death. Transplant. Proc. 2014; 46(9): 3138-3142. https://doi.org/10.1016/j.transproceed.2014.09.169.
23. Kenmochi T, Nishiyama S, Hayashi M, et al. Organ donation from brain-dead and circulatory-dead donors: single-institution experiences. Transplant. Proc. 2014; 46(4): 1051-1053. https://doi.org/10.1016/j.transproceed.2013.11.064.
24. Domínguez-Gil B, Duranteau J, Mateos A, et al. Uncontrolled donation after circulatory death: European practices and recommendations for the development and optimization of an effective programme. Transpl. Int. 2016; 29(8): 842-859. https://doi.org/10.1111/tri.12734.
25. Giannini A, Abelli M, Azzoni G, et al. "Why can't I give you my organs after my heart has stopped beating?" Main clinical, organisational, ethical and legal issues concerning organ donation after circulatory death in Italy. Milan: Università degli Studi di Milano; 2016 [cited 2025 Feb 20]. Available from: https://air.unimi.it/handle/2434/381186.
26. Hodgson R, Young AL, Attia MA, et al. Impact of a national controlled donation after circulatory death programme on organ donation in the United Kingdom: a 10-year study. Am. J. Transplant. 2017; 17(12): 3172-3182. https://doi.org/10.1111/ajt.14374.
27. Lomero M, Gardiner D, Coll E, et al. Donation after circulatory death today: an updated overview of the European landscape. Transpl. Int. 2020; 33(1): 76-88. https://doi.org/10.1111/tri.13506.
28. Lepoittevin M, Giraud S, Kerforne T, et al. How to improve results after DCD (donation after circulation death). Presse Med. 2022; 51(4): 104143. https://doi.org/10.1016/j.lpm.2022.104143.
29. Summers DM, Watson CJE, Pettigrew GJ, et al. Kidney donation after circulatory death (DCD): state of the art. Kidney Int. 2015; 88(2): 241-249. https://doi.org/10.1038/ki.2015.88.
30. Truby LK, Casalinova S, Patel CB, et al. Donation after circulatory death in heart transplantation: history, outcomes, clinical challenges, and opportunities to expand the donor pool. J. Card. Fail. 2022; 28(9): 1456-1463. https://doi.org/10.1016/j.cardfail.2022.03.353.
31. Ceulemans LJ, Vanluyten C, Monbaliu D, et al. Lung transplant outcome following donation after euthanasia. J. Heart Lung Transplant. 2022; 41(6): 745-754. https://doi.org/10.1016/j.healun.2022.01.1375.
32. Chassot M, Scheen M, Wassmer CH, et al. Donor after circulatory death in pancreas transplantation: a scoping review of the literature. Front. Transplant. 2025; 4: 1517354. https://doi.org/10.3389/frtra.2025.1517354.
33. Molina M, Domínguez-Gil B, Pérez-Villares JM, et al. Uncontrolled donation after circulatory death: ethics of implementation. Curr. Opin. Organ. Transplant. 2019; 24(3): 358-363. https://doi.org/10.1097/MOT.0000000000000648.
34. Doerry K, Oh J, Vincent D, Fischer L, et al. Religious and cultural aspects of organ donation: narrowing the gap through understanding different religious beliefs. Pediatr. Transplant. 2022; 26(7): e14339. https://doi.org/10.1111/petr.14339.

Manuscript received: 25.03.2025
Manuscript accepted: 01.07.2025