







Interdisciplinary Management of Cardiotoxicity in Outpatient Settings: A Survey on Practices, Perceptions and Potential for Improvement

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Abstract

Background: Cardiotoxicity is a major concern in patients undergoing chemotherapy, requiring interdisciplinary management. However, the extent to which cardiotoxicity is managed in the outpatient setting among these specialists may vary, potentially leading to gaps in patient care. **Methods:** This questionnaire study assessed the current practices and perceptions of cardiologists, oncologists and gynaecologists regarding the management of cardiotoxicity in patients undergoing outpatient chemotherapy in Germany. **Results:** A total of 1,329 medical professionals were contacted via an online questionnaire; 132 (9.9%) were included in the survey. The participants in our survey reported treating a total of 1,905 chemotherapy patients per month (range 1–200). Of these patients, only 37% of those treated by oncologists (n=13) and 48% of those treated by gynaecologists (n=53) received cardiological care. The results showed that 37% (49/132) of the healthcare professionals surveyed said they performed cardiovascular toxicity risk assessment of chemotherapy in their clinical practice. More than half of the participants (56%, 39/70) expressed a need for simplified cardio-oncology guidelines. The majority of participants (84% [59/70] and 83% [58/70], respectively) requested tools to assist in cardiovascular toxicity risk assessment and the implementation of appropriate therapeutic measures for patients undergoing chemotherapy. **Conclusion:** Our study underscores potential interdisciplinary care gaps, possibly increasing the risk of undetected cardiotoxicity. Variations in cardiotoxicity management among specialities highlight the need for increased awareness and improved collaboration. Interdisciplinary clinical pathways could address these issues, as could a dedicated cardio-oncology network for primary care physicians' support.

Keywords

Cardiotoxicity, interdisciplinary management, healthcare practices, survey, cardiovascular risk assessment, cardio-oncology guidelines

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Ethics: This is an anonymous observational study. The ethics commission of TUD Dresden University of Technology has confirmed that no ethical approval is required.

Consent: Written informed consent was obtained from all individuals included in the study.

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Cardiotoxicity is a well-known and clinically significant adverse effect of various chemotherapeutic agents, posing significant risks to the health and wellbeing of cancer patients.¹ Effective management of cardiotoxicity requires interdisciplinary collaboration among cardiologists, oncologists and other healthcare professionals.^{2,3} However, in Germany, dedicated cardio-oncology units are predominantly situated within university

hospitals, while chemotherapy administration can occur in smaller hospitals or outpatient settings. This disparity may lead to an information gap, potentially affecting patient care.

Guidelines and quality indicators developed by professional societies, including the European Society for Medical Oncology, the American

Society of Clinical Oncology, the European Society of Cardiology (ESC) and the European Hematology Association, aim to mitigate this issue.⁴⁻⁷ These guidelines, along with national ones such as the German S3 guideline “Diagnosis, Therapy and Follow-up of Breast Cancer,” provide evidence-based recommendations for healthcare professionals to assess risk factors for cardiovascular toxicity, monitor cardiotoxicity and administer appropriate cardio-protective therapies.^{7,8}

Despite these measures, there is limited information about healthcare professionals’ practices, experiences and perceptions of managing cardiotoxicity in patients with cancer, particularly their adherence to and perception of these guidelines. Considering this, our study aims to explore the current practices and perceptions of cardiologists, oncologists and gynaecologists in four eastern German states regarding the management of patients undergoing chemotherapy. We focus specifically on the assessment of cardiovascular toxicity risk factors, the monitoring of cardiotoxicity and the use of cardio-protective medications. Furthermore, we aim to evaluate these professionals’ satisfaction with the existing cardiological care and cardio-oncology guidelines provided by various professional societies. By identifying potential areas for improvement in the interdisciplinary management of patients undergoing chemotherapy, our study may guide future efforts to optimise patient care and guideline adherence.

Methods

For this study, we used a cross-sectional, anonymous survey design, in which we administered the questionnaire to all practising statutory health insurance cardiologists, oncologists and gynaecologists in the four eastern German states (Saxony, Saxony-Anhalt, Thuringia, Brandenburg and Mecklenburg-Western Pomerania). We identified a total of 1,716 physicians through the regional associations of statutory health insurance physicians (Kassenärztliche Vereinigungen). Of these, 1,329 had an email address on record so we could invite them to participate by email between March and September 2022. We contacted all potential study participants twice via email as part of our comprehensive outreach effort. During the initial phase in which we collected contact information, we made no selection in order to determine whether the contacted individuals prescribed chemotherapy to patients. Instead, we addressed this aspect through the study title and the first question of the survey, which served as a specific filter. If participants indicated that they did not treat patients with chemotherapy, they were then excluded from the study. This approach ensured that the survey targeted an appropriate audience while recognising the complexity of identifying relevant participants in the field of cardio-oncology.

To evaluate the degree to which guidelines inform practice, we constructed a survey composed of 29 questions spanning various dimensions of cardio-oncology. These included experience with managing patients undergoing chemotherapy, procedures for diagnosis, cardiotoxic risk stratification, pharmacological prevention and treatment of cardiotoxicity, interprofessional satisfaction with patient care and satisfaction with the use of guidelines. The questions pertaining to diagnosis, prevention, and treatment of cardiotoxicity were informed by the aforementioned guidelines.^{7,8} The questionnaire concluded with a section inviting medical experts from the three professions to provide their insights and suggestions for future advancements in the management of cardiotoxicity. The methodology of the questionnaire involved a cascading question system, selectively unlocking subsequent questions based on specific responses to preceding ones. This tailored approach facilitated more precise data collection, targeting only those respondents for whom the questions were applicable.

We initially pretested the questionnaire among our colleagues in order to ensure its validity and comprehensibility, leading to additional clarifications for some of the more complex questions.

We collected data anonymously and analysed them using descriptive statistics with SPSS (IBM) to identify patterns and trends in the responses. We used analyses of variance (ANOVA) to test for significant differences in satisfaction with cardiac care between the respondents from the three professions. We used Spearman correlation analysis to test for correlation between satisfaction with cardiac care and number of patients treated. Significance threshold was $p \leq 0.05$.

Prior to answering the questions, participants were asked for their consent for the further use and publication of the survey results by checking a box on the first page of the questionnaire. The study was conducted in accordance with ethical standards. Due to the anonymous nature of the survey, ethical approval was not required, as ensured by consultation with a data protection specialist at the TUD Dresden University of Technology.

Results

Participant Distribution and Patient Management

The number of surveyed participants was 132 (9.9% of the 1,329 invited to participate) after the selection process. The 132 participants comprised 76 (58%) gynaecologists, 17 (13%) oncologists and 28 (21%) cardiologists, who were asked about the management of patients undergoing chemotherapy. Four participants (3%) did not provide an answer, and seven (5%) stated that they did not belong to any of the three mentioned specialities.

The respondents to our survey reported that they treat a total of 1,905 chemotherapy patients per month. The average number of patients treated per month for each profession is as follows: cardiologists treat 10.4 (1–30) patients ($n=26$), oncologists treat 63.3 (1–200) patients ($n=15$), and gynaecologists treat 12.7 (1–160) patients ($n=54$).

Tumours Commonly Treated

The most commonly treated tumours varied between professions. For gynaecologists, the top three were breast cancer, ovarian and adnexal tumours and uterine body cancers. Oncologists most frequently treated bowel cancer, haematological malignancies and lung cancer (see *Supplementary Table 1*).

Cardiological Care

According to the respondents, patients undergoing cardiotoxic chemotherapy delivered by oncologists ($n=13$) and gynaecologists ($n=48$) also saw a cardiologist in 37% and 48% of cases, respectively. Reasons for no cardiac care in cancer patients are summarised in *Table 1*. The reason most stated by gynaecologists was that there is not always an indication for additional cardiac care (54%). Among oncologists, the most common reasons were an assumed lack of capacities for cardiac care with the resident cardiologist (36%) and that there is not always an indication for additional cardiac care (32%).

Cardiovascular Toxicity Risk Assessment

The results showed that 37% (49/132) of the surveyed medical professionals reported performing cardiovascular toxicity risk assessment in their clinical practice. However, it should be noted that only 48% (63/132) of respondents answered the question.

Common risk factors recognised by professionals from respective

Table 1: Reasons for No Cardiac Care in Cancer Patients as Reported by Oncologists and Gynaecologists

Reasons for No Cardiac Follow-up/Treatment	Oncologists (n=13)	Gynaecologists (n=53)
There is not always an indication for additional cardiac care	32%	54%
The resident cardiologists lack the necessary capacities for cardiac care	36%	19%
No relevant consequences for the therapy of the patients are to be expected from the additional cardiac care	14%	12%
Although there is contact with a resident cardiologist, it is not sufficient to derive therapeutic consequences from it	11%	6%
Reasons for no co-supervision: other	7%	9%

specialities as genuine risk factors for cardiotoxicity included previous heart disease, high-dose anthracycline therapy, human epidermal growth factor receptor 2 (HER2) and/or proteasome inhibitor therapy, obesity, age and radiotherapy (Table 2). However, it is noteworthy that elevated cardiac biomarkers were only considered relevant for cardiotoxicity risk assessment by a fraction of respondents: 20% of cardiologists and 38% of gynaecologists.

Assessing Cardiotoxicity

When asked about cardiotoxicity, 66% of all respondents agreed that any decrease in ejection fraction was a relevant marker for cardiotoxicity. However, results varied between professions: 79% of the cardiologists agreed with the corresponding statement, while 58% of oncologists and 40% of gynaecologists agreed with it. Detailed information is shown in Table 3. It is noteworthy that only 50% (66/132) of those surveyed responded to this question.

Among the cardiologists, 55% (11/20) had used global longitudinal strain (GLS) when monitoring cardiovascular risks. The three most common reasons for not conducting myocardial strain analysis were a lack of time (56%), a lack of technical equipment (44%) and not having the necessary expertise to perform the examination (44%).

On average, 13% of patients receiving chemotherapy underwent cardiac biomarker testing under medical supervision according to the respondents in our survey (n=70). Consensus was observed among all surveyed specialities – oncologists, gynaecologists and cardiologists – on the necessity of performing biomarker tests in the event of acute patient complaints. Specifically, 100% of oncologists and gynaecologists and 92% of cardiologists adhere to this practice. Supplementary Table 2 provides a comprehensive analysis of the timing of biomarker testing across these specialities. Among the cardiologists, the most common reason for not performing cardiac marker testing was the belief that it was the responsibility of either the oncologist or the general practitioner, with 44% and 33% stating each, respectively. Similarly, 57% of the gynaecologists indicated that it is the joint responsibility of oncologists and cardiologists.

Use of Cardio-protective Medications

In response to the question regarding who initiates cardioprotective therapy, the data showed that it is primarily cardiologists who do so, followed by oncologists and then general practitioners involved in the patient’s care (see Supplementary Figure 1).

Satisfaction with Cardiological Care and Needs for Improvement

The gynaecologists and oncologists in our study expressed overall satisfaction with the cardiological care provided to their patients, with no significant differences between the professions detected by analysis of variance (F=2.201; p=0.144). Slightly more than half (56%, 39/70) expressed

Table 2: Summary of Selected Cardiovascular Toxicity Risk Factors According to Speciality

CV Toxicity Risk Factor	Oncologists (n=12)	Gynaecologists (n=24)	Cardiologists (n=10)
Cardiac disease	100%	100%	100%
High-dose anthracycline*	92%	100%	70%
HER2 and/or proteasome inhibitor	83%	96%	40%
Obesity	83%	71%	70%
Age >60 years	58%	71%	90%
Radiotherapy†	83%	54%	70%
Diabetes	67%	50%	100%
LVEF dysfunction	67%	54%	80%
Elevated cardiac biomarkers	67%	38%	20%
Anti-VEGF therapy	50%	46%	20%
Sex	42%	25%	80%

CV = cardiovascular; HER2 = human epidermal growth factor receptor 2; LVEF = left ventricular ejection fraction; VEGF = vascular endothelial growth factor. *Doxorubicin ≥250 mg/m² or epirubicin ≥600 mg/m². †Radiotherapy with the heart in the radiation field

Table 3: Comparison of Echocardiographic Criteria for Relevant Cardiotoxicity among Oncologists, Gynaecologists and Cardiologists

Criteria for Relevant Cardiotoxicity	Oncologists (n=12)	Gynaecologists (n=35)	Cardiologists (n=19)
LVEF reduction >10% below limit	8%	5%	21%
LVEF reduction >20% below limit	25%	11%	-
LVEF reduction >30% below limit	-	14%	-
Any reduction in LVEF represents toxicity	58%	40%	79%
I don't know	8%	29%	-

LVEF = left ventricular ejection fraction.

a wish for simplified guidelines related to cardiological co-care, while 84% (59/70) and 83% (58/70), respectively, requested tools for risk assessment and implementation of appropriate therapeutic measures for patients undergoing chemotherapy. Analysis of variance showed no differences in the extent of these requests between the professions (F=0.343, p=0.711; F=1.516, p=0.227).

The satisfaction of oncologists and gynaecologists with their patients’ cardiology care was not significantly related to the number of cases treated (r=0.51, p=0.724).

Discussion

This study, conceived as a hypothesis-generating and therefore exploratory investigation, aimed to evaluate the current practices and perceptions of cardiologists, oncologists and gynaecologists in the management of patients undergoing chemotherapy, focusing on the assessment of cardiac risk factors, monitoring of cardiotoxicity, and use of cardio-protective medications. Overall, the study identified several areas that should be further evaluated in subsequent studies in order to improve the multidisciplinary management of patients.

Cardiac Care

The fact that, according to the practitioners we surveyed, less than half of patients receiving cardiological chemotherapy are under cardiological care must be discussed from various perspectives. A key point is the lack of cardiological capacities. Although Germany has a high gross domestic product *per capita*, the density of cardiologists per million people (45.35), is lower than the overall European average (103.6).⁹ Furthermore, less than one-third of these cardiologists work in the outpatient sector, which was the focus of our survey.¹⁰ An even more interesting finding was that a significant proportion of respondents did not see the necessity for cardiological co-treatment in patients undergoing cardiotoxic chemotherapy.

According to the cardio-oncology guidelines, cardiological co-care is recommended only for cancer patients at high or very high risk for developing cardiac dysfunction, which may explain why some oncologists and gynaecologists do not see the need for cardiological examination.⁶ Additionally, we did not explicitly ask about the type of chemotherapy in the questionnaire, so patients receiving non-cardiotoxic chemotherapy could also fall into this category. However, in our survey, we specifically asked about cardiotoxic chemotherapeutic agents. Additionally, an echocardiogram is recommended as a baseline examination for most available chemotherapeutic agents.⁶ Given that, in Germany, echocardiographic examinations in an outpatient setting are exclusively performed by cardiologists, as this is only part of cardiological specialist training, the number of patients not receiving a cardiological consultation appears too high. This finding may highlight a potential shortcoming in the interdisciplinary care of these patients, which may increase the risk of unrecognised cardiotoxicity and associated complications.

Lack of Cardiovascular Toxicity Risk Assessment

Cardiovascular toxicity risk assessment is a cornerstone of cancer patient treatment.¹¹ The results showed that only a small portion of the surveyed medical professionals reported performing cardiovascular toxicity risk assessment in their clinical practice.

Furthermore, our study showed that elevated cardiac biomarkers and treatment with certain therapies (e.g. HER2 or proteasome inhibitors and anti-vascular endothelial growth factor therapy) were not considered by a substantial proportion of physicians of our study when performing risk stratification during chemotherapy. It is unclear why cardiac biomarkers – which can be determined cost-effectively and require minimal medical resources – are not measured more frequently and routinely, especially concerning indications such as early detection of cardiotoxicity, monitoring the impact of therapy on cardiac function and stratifying patient risk before initiating potentially cardiotoxic treatment regimens.¹²

There are a variety of recommendations that suggest measuring cardiac serum biomarkers, such as cardiac troponin (cTn) I or T and natriuretic peptides (NPs; e.g. B-type NP [BNP] or N-terminal pro-BNP), can assist in

baseline cardiovascular risk assessment of patients undergoing cancer treatments.^{12–14}

A high baseline cTn level has been identified as a predictor of poor recovery, even with optimal heart failure therapy.¹⁵ This finding was subsequently confirmed in a study of 533 breast cancer patients who underwent trastuzumab therapy. An increased baseline level of cTn was associated with a four-fold risk of developing left ventricular (LV) dysfunction.¹⁶ The NPs in identifying individuals susceptible to cardiovascular dysfunction due to chemotherapy should be assessed with nuance and differentiation. The initial NP levels have been shown to be the strongest predictor of cardiac events, and research implies that BNP in particular could serve as a valuable early detection method for identifying significant heart-related events during the course of anthracycline treatment for sarcoma, lymphoma and breast cancer.^{17,18}

However, as demonstrated by a meta-analysis of 10 studies (462 patients), BNP levels did not consistently predict LV dysfunction (OR 1.7; 95% CI [0.7–4.2]).¹² It must be noted as a limitation that the meta-analysis focused solely on LV dysfunction and did not examine diastolic functional disturbances. These conditions are associated with varying BNP elevations.¹⁹

Variability in Cardiotoxicity Assessment Criteria

Our findings show that there is some variability in the echocardiographic criteria considered relevant for cardiotoxicity among oncologists, gynaecologists and cardiologists. Similar findings have been presented by Chavez-MacGregor et al.²⁰ Within our study, the most commonly selected criterion across all three groups was “any reduction in ejection fraction (LVEF) represents relevant cardiotoxicity.” However, this approach can lead to inaccurate assessments of cardiotoxicity, since alterations in loading conditions (such as volume changes due to intravenous fluids, volume loss from vomiting or diarrhoea and fluctuations in blood pressure and heart rate caused by pain or stress) are common during chemotherapy, which can impact the quantification of cardiac volumes LVEF and GLS.^{21–24} Current publications categorise cardiotoxicity into three severity levels: severe, moderate and mild, with relevant cardiotoxicity being defined as an LVEF of $\geq 50\%$ with a new relative decline in GLS by $>15\%$ from baseline and/or a rise in cardiac biomarkers.⁶ Older publications define it as a decrease in LVEF by $>10\%$ to a value $<53\%$ (the normal reference value for 2D echocardiography).^{1,25} However, questions within the survey dealing with echocardiographic criteria were only answered by 8% of oncologists, 8% of gynaecologists and 20% of cardiologists. These results indicate a potential gap in knowledge dissemination or adherence to these cardio-oncology guidelines, a finding mirroring those of a survey among US cardiologists.²⁶ Furthermore, this finding holds significant clinical importance, as the success of heart failure therapy is time-dependent, with the proportion of patients responding to treatment gradually declining as the duration until heart failure treatment increases.²⁷ This highlights the importance of ongoing education and communication across disciplines to ensure that medical professionals are up-to-date and consistently applying the established guidelines. By enhancing interdisciplinary collaboration and promoting a better understanding of the guidelines, the accuracy of cardiotoxicity assessment can be improved, ultimately leading to better patient outcomes. Corresponding results have been observed in several studies examining implementation strategies for clinical guidelines, showing their importance in assuring clinical impact of guidelines.^{28–30} This is particularly relevant given that limited adherence to guidelines has been found in several retrospective studies; for example, in Dutch breast cancer patients treated with trastuzumab or in patients in the US with the same diagnosis.^{31,32}

Demand for Simplified Guidelines and Tools

Our study revealed that oncologists and gynaecologists were generally satisfied with the cardiological care provided to their patients. However, they expressed a need for simplified guidelines related to cardiological co-care and tools for risk assessment and implementing appropriate therapeutic measures during chemotherapy. This is consistent with results of the above-mentioned survey conducted among cardiologists in the US.²⁶

The interdisciplinary field of cardio-oncology has experienced significant growth in the past decade. It is currently witnessing an exponential growth in publications and an annual increase in citations, signifying its emergence as a prominent research area in cardiology.³³ For example, the new ESC cardio-oncology guidelines are a comprehensive 133-page document with 272 new recommendations that require multidisciplinary collaboration and resources.⁶ However, the extensive nature of new research and guidelines can be challenging for individual practitioners or small clinics starting to incorporate cardio-oncology into their clinical practice.

On the one hand, this emphasises the unmet demand and urgent need for a dedicated and comprehensive cardio-oncology care network. Providing early access to cardio-oncology services has been shown to improve patients' understanding of the link between cancer treatment and cardiotoxicity.³⁴ In addition, early access to treatment for cardiovascular disease has been associated with a reduction in cardiovascular complications, improved recovery of cardiac function and better overall cardiovascular outcomes.³⁵

On the other hand, until the necessary infrastructure is in place, practising physicians need to be equipped with tools (such as dedicated, easy-to-use apps, access to cardio-oncology networks, etc.) that can assist them in all steps of cardio-oncology care, from cardiovascular toxicity risk assessment to diagnosis and treatment, based on the latest scientific evidence.

Limitations

There are several limitations to this study that should be taken into consideration. First, although 1,329 physicians were contacted, the inclusion rate was only 9.9%. It is important to note that this rate reflects the specific selection criteria, as only participants who treated patients with chemotherapy were included in the study. As gynaecologists constituted nearly 80% of all contacted individuals, and only a small fraction of this group prescribes chemotherapy, the inclusion rate was consequently low. This aspect of the methodology does not imply a lack of interest in the field of cardio-oncology; instead, it reflects the targeted approach taken to ensure that the survey reached the relevant audience. Second, because of the cascading nature of our survey, some questions were not applicable to all respondents and, therefore, remained unanswered. This aspect, while intentional in design, may give the appearance of incomplete data. However, it should be noted that this structure allowed for more relevant and focused responses from each participant, enhancing the precision and applicability of our findings. Third, the study design was cross-sectional, which limits the ability to draw causal inferences or determine changes over time. Fourth, the study relied on self-reported data from participants, which may be subject to recall bias or social desirability bias. Fifth, the study focused exclusively on the practices and perceptions of physicians and did not assess the perspectives of patients or their caregivers. Sixth, our survey's design did

not differentiate between individual cardiotoxic treatments, limiting our ability to assess specific cardiotoxic risks and the corresponding variations in management strategies. This approach may obscure the detailed understanding of how risk stratification and monitoring practices vary with each type of chemotherapy agent. As we aimed to gain a basic overview of the distribution of knowledge on cardiotoxicity among the physicians we surveyed, we chose an appropriate survey design. Furthermore, differentiating between treatment regimens would have required in-depth knowledge from participants. The lack of sometimes basic knowledge on cardiotoxicity we uncovered among the physicians surveyed strengthens the rationale for our more general approach. Recognising this limitation is essential for interpreting our findings and highlights the need for future research to focus on the distinct cardiotoxic profiles and management strategies of different chemotherapeutic treatments. Finally, the study only explored a few aspects of the potential barriers to the implementation of cardio-oncology guidelines and interventions, such as lack of cardiological capacity, while other resource constraints or competing demands on physicians' time and attention were not considered.

Conclusion

This study highlights the potential for improvement in the interdisciplinary management of patients undergoing chemotherapy. There is a need for increased awareness of the importance of cardiotoxicity management and interdisciplinary collaboration to improve patient outcomes. The assessment of cardiovascular risk factors and monitoring of cardiotoxicity varied among the specialities, indicating a potential gap in the interdisciplinary care of these patients. Our study revealed the need for simplified guidelines related to cardiological co-care and tools for risk assessment and implementing appropriate therapeutic measures during chemotherapy. On-going education and communication across disciplines can improve the accuracy of cardiotoxicity assessment and promote a better understanding of the guidelines. Ultimately, until the necessary infrastructure is in place, practising physicians need to be equipped with tools that can assist them in all steps of cardio-oncology care based on the latest scientific knowledge. The unmet demand and urgent need for dedicated and comprehensive cardio-oncology care underscores the importance of increasing the number of specialised cardio-oncology clinics and providing early access to cardio-oncology services to improve patient outcomes. □

Clinical Perspective

- There is a need to improve awareness of cardiovascular toxicity risk assessment and to promote an active role for cardiologists in the overall treatment strategy for cancer patients.
- There is a need for improved interdisciplinary care of patients undergoing chemotherapy to prevent unrecognised cardiotoxicity and associated complications.
- There is a need for more frequent and routine use of cardiac biomarkers that are effective in the identification of patients at risk.
- There is a need for simplified cardio-oncology guidelines and tools to assist in risk assessment and implementation of appropriate therapeutic measures during chemotherapy.
- Guidelines need to be accompanied by multi-faceted implementation strategies to foster adherence and clinical impact, which should both be measured continuously.

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