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THE ASSESSMENT OF CLINICAL AND ECONOMIC EFFECTIVENESS OF RADIOFREQUENCY ABLATION WITH IMPLANTED CARDIAC DEVICES IN PATIENTS WITH ATRIAL FIBRILLATION. LITERATURE REVIEW

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Abstract

Introduction. Atrial fibrillation (AFib) is a health condition in which irregular heartbeats are registered in the chambers of the heart. The condition is characterized by the risk of developing blood clots which may lead to stroke.

Objective. To evaluate the clinical and cost-effectiveness and safety of radiofrequency ablation (RFA) with implanted cardiac devices versus the Cox-Maze procedure (CM) in drug-resistant patients with AFib.

Search strategy. PubMed, the Cochrane Library, NICE, and CADTH Evidence Driven have been used for the literature search. Search filters: systematic reviews, meta - analyzes, randomized controlled trials (RCTs); population: humans; date of publication: 5 -20 years. To assess the quality of systematic reviews and meta-analyses, we used the AMSTAR checklist. The ELSI checklist has been applied in order to check RFA for potential ethical, social and legal aspects. The article was peer-reviewed by two independent public health professionals.

Results. The success rates of RFA varied and might be explained by AFib types and an electrophysiologist's clinical experience. From the safety standpoint, the technology may cause rare complications (3-5%) as bleeding, thromboembolism, the pacemaker syndrome and some interactions with cardiac devices such as oversensing or transvenous lead dislodgment. From the societal implications, RFA improves patients' recovery and allows them to be discharged from the clinic in 2-3 days so that it saves hospital resources, whereas CM requires the patients to stay in the hospital for 4 to 6 weeks.

Conclusions. RFA with implanted cardiac devices is clinically effective and generally safe for the treatment of AFib in drug-resistant patients. Also, the health technology is potentially cost - effective and resource-saving for hospitals. Nonetheless, its clinical effects and economic implications in the long turn should be further investigated.

Keywords: *radiofrequency ablation, cardiac devices, clinical effectiveness, atrial fibrillation, cost-effectiveness, Cox – Maze.*

Резюме

ОЦЕНКА КЛИНИЧЕСКОЙ И ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ РАДИОЧАСТОТНОЙ АБЛЯЦИИ С ИМПЛАНТАЦИЕЙ СЕРДЕЧНЫХ УСТРОЙСТВ У ПАЦИЕНТОВ С ФИБРИЛЛЯЦИЕЙ ПРЕДСЕРДИЙ. ЛИТЕРАТУРНЫЙ ОБЗОР

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Введение. Фибрилляция предсердий (ФП) – это физическое состояние, при котором в камерах сердца регистрируются нерегулярные сердечные сокращения. Данное состояние характеризуется риском развития тромбов, которые могут привести к инсульту.

Цель. Оценить клиническую и экономическую эффективность, безопасность радиочастотной абляции (РЧА) с имплантацией сердечными устройствами по сравнению с процедурой Кокс – Мейз (КМ) у фармако-резистентных пациентов с ФП.

Стратегия поиска. Для литературного поиска были использованы базы данных PubMed, the Cochrane Library, NICE, и CADTH Evidence Driven. Фильтры поиска: систематический обзор, мета-анализ, рандомизированные контроллируемые исследования (РКИ); популяция: люди; дата публикации: 5-20 лет. Для оценки качества систематических обзоров и мета-анализов, мы использовали чек-лист AMSTAR. Чек-лист ELSI был применен для проверки РЧА на предмет потенциальных этических, организационных, социальных и правовых аспектов технологии. Статья была рецензирована двумя независимыми специалистами общественного здравоохранения.

Результаты. Показатели успешности РЧА варьировали и могут быть объяснены типами ФП и клиническим опытом электрофизиолога. С точки зрения безопасности, технология может вызывать редкие осложнения (3-5%), такие как кровотечение, тромбоэмболия, синдром кардиостимулятора и некоторые взаимодействия с сердечными устройствами, включая повышенную чувствительность или трансвенозное вытеснение свинца. С позиции социальных последствий, РЧА улучшает выздоровление пациентов и позволяет выписываться из клиники в течение 2-3 дней, что экономит ресурсы больницы, тогда как КМ требует, чтобы пациенты оставались в больнице от 4 до 6 недель.

Выводы. РЧА с имплантированными сердечными устройствами - клинически эффективен и, в целом, безопасен для лечения фармако-резистентных пациентов с ФП. Кроме того, данная технология здравоохранения потенциально экономически эффективна и экономит ресурсы больниц. Тем не менее, ее клинические эффекты и экономические последствия в долгосрочной перспективе должны быть дополнительно изучены.

Ключевые слова: *радиочастотная абляция, сердечные устройства, клиническая эффективность, мерцательная аритмия, экономическая эффективность, Кокс – Мейз.*

Түйіндеме

ЖҮРЕКШЕ ФИБРИЛЛЯЦИЯСЫ БАР ПАЦИЕНТТЕРДЕ ЖҮРЕК ҚҰРЫЛҒЫЛАРЫН ИМПЛАНТАЦИЯЛАУМЕН РАДИОЖИІЛІКТІ АБЛЯЦИЯНЫҢ КЛИНИКАЛЫҚ ЖӘНЕ ЭКОНОМИКАЛЫЛЫҚ ТИІМДІЛІГІН БАҒАЛАУ: ӘДЕБИ ШОЛУ

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Кіріспе. Жүрекше фибрилляциясы (ЖФ) – бұл жүрек камераларында тұрақты емес жүрек қысқартулары тіркелетін физикалық жағдай. Бұл жағдай инсультке әкелуі мүмкін тромбтардың даму қаупімен сипатталады.

Мақсаты. ЖФ бар фармако-резистентті емделушілерде Кокс – Мейз (КМ) процедурасымен салыстырғанда жүрек құрылғыларымен имплантаумен клиникалық және экономикалық тиімділігін, радиожиілік абляциясының (РЖА) қауіпсіздігін бағалау.

Әдістері. Әдеби іздеу үшін PubMed деректер қоры, the Cochrane Library, NICE, CADTH Evidence Driven қолданылды. Іздеу фильтірлері: жүйелі шолу, мета-талдау, рандомизацияланған бақылаудағы зерттеулер (РБЗ); популяция: адамдар; жариялау күні: 5-20 жыл. Жүйелі шолулар мен мета-талдаулардың сапасын бағалау үшін біз AMSTAR чек-парағын қолдандық. ELSI чек-парағы технологияның әлеуетті этикалық, ұйымдастырушылық, әлеуметтік және құқықтық аспектілеріне РЖА тексеру үшін қолданылды. Мақалаға екі тәуелсіз қоғамдық денсаулық сақтау маманы сын пікір берді.

Нәтижелер. РЖА жүргізудің табыстылық көрсеткіштері түрленіп, ЖФ типтерімен және электрофизиологтың клиникалық тәжірибесімен түсіндірілуі мүмкін. Қауіпсіздік тұрғысынан алғанда, технология қан кету, тромбоэмболия, кардиостимулятор синдромы және қорғасынның жоғары сезімталдығын немесе трансвенозды

ығыстырылуын қоса алғанда, жүрек құрылғыларымен кейбір өзара іс-қимыл сияқты сирек асқынуларды (3-5%) тудыруы мүмкін. Әлеуметтік салдар тұрғысынан, РЖА пациенттердің сауығуын жақсартады және 2-3 күн ішінде клиникадан шығаруға мүмкіндік береді, бұл ауруханаңың ресурстарын үнемдейді, ал КМ пациенттердің ауруханада 4-тен 6 аптаға дейін болуын талап етеді.

Тұжырымдар. Имплантацияланған жүрек құрылғылары бар РЖА - клиникалық тиімді және жалпы ЖФ бар фармако-резистентті пациенттерді емдеу үшін қауіпсіз. Бұдан басқа, денсаулық сақтаудың осы технологиясы әлеуетті экономикалық тиімді және ауруханалардың ресурстарын үнемдейді. Дегенмен, ұзақ мерзімді перспективада оның клиникалық әсерлері мен экономикалық салдарлары қосымша зерттелуі тиіс.

Негізгі сөздер*: радиожиілік абляция, жүрек құрылғылары, клиникалық тиімділігі, жыбырлақ аритмия, экономикалық тиімділігі, Кокс – Мейз.*

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Introduction

Atrial fibrillation (AFib) is a health condition in which irregular heartbeats are registered in the chambers of the heart. The condition is characterized by the risk of developing blood clots which may lead to stroke. Approximately 15-20% of patients suffering from stroke experienced this heart arrhythmia. As a result, patients with AFib are recommended to use blood thinners to reduce clotting risks. The risk of heart-related deaths is doubled by untreated atrial fibrillation, however, there is still a lack of awareness in patients about the seriousness of this condition. The unawareness is likely to increase the number of disease cases in a population [23].

According to data presented by the “Republican Center for Electronic Health” of the Ministry of Health of the Republic of Kazakhstan, the total number of atrial fibrillation cases increased from 14851 to 16772 (a 12.9% increase) between 2018 and the first 9 months of 2019 [3] (Table 1).

Table 1.

The number of atrial fibrillation cases in adults in the year 2018 and for 9 months of 2019 for the Republic of Kazakhstan by region.

Region	2018		9 months 2019	
	Total number of diseases recorded	of which are registered for the first time	Total number of diseases recorded	of which are registered for the first time
Akmola region	929	140	1 167	183
Aktobe region	672	86	523	79
Alma-Ata's region	348	85	694	196
Atyrau region	394	99	414	65
East Kazakhstan region	1 595	345	1 808	328
Jambyl Region	265	53	271	93
West-Kazakhstan region	452	68	666	141
Karaganda region	1 469	514	1 279	427
Kostanay region	1 040	286	1 369	230
Kyzylorda Region	614	205	575	152
Mangistau region	339	30	270	50
Pavlodar region	1 248	234	1 758	337
North-Kazakhstan region	2 100	301	1 821	286
Turkestan region	908	155	1 251	203
Almaty	1 721	408	2 177	441
Nur-Sultan	757	105	729	147
Total	**14851**	**3114**	**16772**	**3358**

With this in mind, it seems reasonable to adopt additional measures to fight atrial fibrillation and to reduce this growing tendency. Such following therapies are recommended to treat patients with AFib as antiarrhythmic medications (for example, apixaban, dabigatran etexilate, rivaroxaban), a conventional surgical approach known as the Cox-Maze procedure, and ablation procedures [4]. In this article, we would like to focus on the use of RFA with implanted cardiac devices versus the Cox-Maze procedure.

Radiofrequency ablation with implanted cardiac devices (RFA) is performed in a surgical room. Local intravenous anesthesia is used during the surgery. Once the installation of endocardial electrodes for continuous pacing and the establishment of temporary stimulation of the right ventricle have been done, radiofrequency ablation itself begins. During the operation, the position of the ablation electrode is monitored, based on two criteria: anatomical (when fluoroscopy or X-rays is used) one and registration of the electrogram of the His bundle (electrophysiological criterion). The ablation electrode is located in the anterior septal region of the right atrium. Once potential of the bundle of His is registered, radiofrequency procedure is carried out at temperature of 40-60° C. After that, when an artificial complete atrioventricular (AV) block is obtained, temporary stimulation of the right ventricle supports the heart rhythm.

After assessing the stability of the effect obtained within 30 minutes of observation, the implantation of a constant pacemaker is performed. In most cases, AV blockade is achieved in the first minute of RFA. If RFA is ineffective from the right side of heart, left-side access to the AV connection is used (a feature of the anatomical location of the AV node) [1].

The Cox-Maze procedure (CM) is the "gold standard" in the AFib surgical treatment. CM is carried out during open-heart surgery when a pattern of scar tissue in the heart's upper chambers is created by using a scalpel or an ablation device. As a consequence, abnormal electrical signals that cause some types of arrhythmia are disrupted [18].

The purpose of this review is to evaluate the clinical and cost-effectiveness of the technologies and their safety aspects. This is applied to current interventions (comparators) as well to make rational decisions regarding the selection of the most suitable medical practice for a patient with atrial fibrillation.

Methodology

A literature search was conducted in databases such as PubMed, the Cochrane Library Systematic Reviews Database, NICE, Google Scholar and CADTH Evidence Driven. The inclusion criteria were as follows: systematic reviews, meta - analyzes, randomized controlled trials (RCTs)**;** patients with atrial fibrillation; patients with cardiac devices: a permanent pacemaker, a biventricular and automatic cardioverter defibrillator**;** dates of publication: 5 or 20 years. The exclusion criteria were as follows: non-randomized clinical trials, children, and animals. The search was not restricted to any language. Although, priority was given to high-quality studies, we also took into consideration the findings of observational studies and of "grey literature". To evaluate the quality of the included articles, we used the AMSTAR checklist (Appendix - Table 3). Ethical, organizational, legal and professional issues have been analyzed by using the ELSI checklist (Appendix-Table 4). The review article was peer-reviewed by two health care workers. The total number of sources used in this review article including guidelines, websites, and reports is 24 (Figure 1).

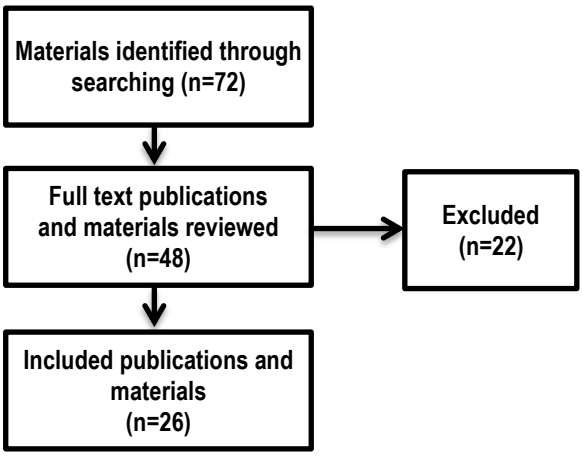

Figure 1 - The flow chart of the literature search and selection.

To define a research question, the PICO (Population, Intervention, Comparators, Outcomes) Model was used (Table 2).

Table 2..

The PICO Model.

Population	Patients with atrial fibrillation
Intervention	Radiofrequency ablation
Comparators	Surgical ablation (Cox Maze or the cut and sew procedure)
Outcomes	Clinical effectiveness and safety cost –effectiveness, cost-savings and quality-adjusted life-year

Results

Examining the clinical effectiveness of RFA, significant reductions in all-cause mortality (Relative Risk 0.42, 95% Confidence Interval 0.26 - 0.68) and in cardiovascular mortality (Relative Risk 0.44, 95% Confidence Interval 0.24 - 0.81) have been attributed to ablation in patients with AFib and heart failure [10]. Similarly, the effectiveness of ablation was confirmed in a systematic review and meta-analysis by Wilton et al. (2011). The study included 7,495 AFib patients with cardiac resynchronization therapy (CRT). In patients suffering from AFib, RFA showed a lower risk of clinical nonresponse (Relative Risk 0.40; 95% Confidence Interval 0.28 - 0.58; P<0.001) and a reduced risk of death. Wilton and colleagues claim that the use of RFA with a cardiac catheterization procedure would allow physicians to achieve adequate biventricular pacing in those with cardiac antiarrhythmias [25].

Table 3.

Critical Appraisal of Included Systematic Reviews and Meta-Analyses.

AMSTAR Item		Strengths and Limitations of Systematic Reviews and Meta-Analyses using the AMSTAR checklist			
		Clinical effectiveness			
		Wilton et al. (2011)	Jiang et al. (2018)	McClure et al. (2017)	Kong et al. (2010)
Did the research questions and inclusion criteria for the review include the components of PICO?		⊕	⊕	⊕	⊕
Was there duplicate study selection and data extraction?	**selection**	⊕	⊕	⊕	⊕
	extraction	⊕	⊕	⊕	⊕
Was a comprehensive literature search performed?		⊕	⊕	⊕	⊕
Was a list of studies (included and excluded) provided?	**included**	⊕	⊕	⊕	⊕
	excluded	X	X	X	X
Was the status of publication used as an inclusion criterion?		⊕	⊕	⊕	⊕
Were the characteristics of the included studies provided?		⊕	⊕	⊕	⊕
Was the scientific quality of the included studies assessed and documented?		⊕	⊕	⊕	⊕
Was the scientific quality of the included studies used apropriately in formulating conclusions?		⊕	⊕	⊕	⊕
Were the methods used to combine the findings of studies appropriate?		⊕	⊕	⊕	⊕
Was the conflict of interest included?		⊕	⊕	⊕	⊕

Legend: ⊕ = Yes, X = No, ? = Unclear N/G = not given

Table 4.

ELSI checklist.

Template: Checklist for potential ethical, organisational, patient and social and legal aspects	
1. Ethical	
1.1. Does the introduction of the new technology and its potential use/non-use instead of the defined, existing comparator(s) give rise to any new ethical issues?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: Routine introduction of prenatal genetic screening tests, which could lead to pregnancy termination, may cause ethical issues for the couple as well as for the health-care provider.	
1.2. Does comparing the new technology to the defined, existing comparators point to any differences that may be ethically relevant?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: The sponsor claims that its product is superior, but has decided to limit the amount of the new medicine, which means that it has to be rationed and not all patients who need it can receive it. The comparator is freely available.	
2. Organisational	
2.1. Does the introduction of the new technology and its potential use/non-use instead of the defined, existing comparator(s) require organisational changes?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: The new intervention requires the establishment of specialised centres for administration.	
2.2. Does comparing the new technology to the defined, existing comparator(s) point to any differences that may be organisationally relevant?	**Yes**
If answered with 'yes', please provide a short statement explaining why.	Patients' hospital stay, health care costs and post-operative complications can be reduced by RFA with pacemakers
Example: The new technology will replace a surgical intervention, which may lead to excess capacity in relevant areas.	

Continuation Table 4.

3. **Social**	
3.1. Does the introduction of the new technology and its potential use/non-use instead of the defined, existing comparator(s) give rise to any new social issues?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: A new technology allows patients to return to the workplace, but since the technology can be seen by co-workers, it may lead to stigmatisation.	
3.2. Does comparing the new technology to the defined, existing comparator(s) point to any differences that may be socially relevant?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: A technology, which is widely used by persons with abuse problems, colours the tongue blue, thus, immediately identifying the user. Comparators do not have this property.	
4. **Legal**	
4.1. Does the introduction of the new technology and its potential use/non-use instead of the defined, existing comparator(s) give rise to any legal issues?	**No**
If answered with 'yes', please provide a short statement explaining why.	
Example: The comparator for the new technology is a pharmaceutical that is not licensed for the indication of concern, but is widely in use.	
4.2. Does comparing the new technology to the defined, existing comparator(s) point to any differences that may be legally relevant?	**No**
If answered with 'yes', please provide a short statement explaining why.	

A meta-analysis of 16 studies by Jiang et al. (2018) included 785 patients, namely over 60 % with longstanding persistent AFib patients underwent RFA. It is reported a pooled AFib-free survival of 73% off, increasing to 83% and making the use of antiarrhythmic medications and/or repeat catheter ablations possible. In this study, the authors state that ablation demonstrates its effectiveness and safety. The pooled rate of severe short-term complications was 4% (95% Confidence Interval 2%-7%, I^2 statistic (heterogeneity) = 51, p = 0.01). In other words, the procedure has a higher success rate and does not result in severe complications. Nevertheless, the authors highlight a need for additional randomized controlled trials to make sure the validity of these results [12].

Compared with RFA, surgical intervention (also known as the Cox - Maze procedure CM) is associated with significant complications in some cases. For example, McClure et al. (2017) state that there is a higher pacemaker implantation incidence in the surgical cohort compared with the catheter one, 5.4% as opposed to 1.5%. Thus, CM is associated with sinus atrial node injury and dysfunction. This fact explains the higher incidence of pacemaker implementation that has been observed [15]. However, CM may be performed in patients with AFib after failed RFA or as an alternative to it either due to contraindications or due to patient choice [9].

When it comes to examining the success rates of RFA and CM, the success rates of those health technologies vary in terms of clinical outcomes. For instance, in the RFA patients, there were variations between 60% to 80% for paroxysmal AFib (PAF) and between 50% to 60% for those with persistent AFib [20]. The RFA's success rate is dependent on the experience of an electrophysiologist performing catheter ablation procedures [17]. In general, the success rate was in the range of between 50% and 80% [20]. In contrast to the RFA, the CM procedure has an overall success rate of about 90% and 99% for freedom from stroke after surgery [14].

From an economic standpoint, RFA is potentially cost-effective (incremental cost-effectiveness ratio or ICER £7763 to £7910) for the treatment of drug-refractory patients with paroxysmal AFib, treatment provides the quality-of-life benefits for several years [16].

In a study by Aronsson et al. (2014), the authors state that RFA as first-line treatment is a cost-effective treatment for paroxysmal AFib patients at age of less 50 years in some European countries (ICER of €50,570 per quality-adjusted life-year or QALY). Nonetheless, to make RFA a cost-effective first-line treatment in individuals at age of 50 and higher, we must increase the willingness to pay for a QALY (more than €100,000) [5].

With respect to CM, it had higher costs per a patient than RFA, $232,162 and $208,371, respectively. However, CM patients had higher QALYs compared to those undergoing the ablation procedure, 12.4 and 10.2, respectively [26]. This research supports the idea that RFA is more preferable in terms of costs. For example, RFA with implantation of permanent cardiac device costs led to a reduction in costs for 1 patient treatment from 6.9% to 15.2% (1 018 USD for both). This economic effectiveness is explained by a reduction in hospital stay duration and no need for additional anaesthetic supplies [7].

In Kazakhstani Diagnosis-Related Groups (DRGs), costs for stand-alone RFA vary from 1 128 507,13 to 1 504 676,17 tenge [2] The tariffs are different for adults and children staying at either hospital or day hospital settings. Also, according to data provided by Medical Centre Hospital of the President's Affairs Administration of the Republic of Kazakhstan, the estimated cost of RFA with the implantation of an automatic cardioverter / a biventricular defibrillator for one patient is 5 829 445 tenge (KZT) (or 13 106 US dollars based on official (market) exchange rates (USD / KZT - 444.8 tenge) on March 24, 2020 on the website of National Bank of Kazakhstan). By contrast, if a permanent pacemaker is implanted during the RFA, the cost will be lower, 2 335 818 tenge (or 5 251 US dollars). As

we can see the cost of the RFA depends on the type of cardiac device used [1]. The price of pacemakers in Kazakhstan seems very low - as in potentially barely covering the cost of the device in comparison with costs used in the above studies. However, the cheapness might be delusive because DRGs reimburse only one intervention at a time. It means that two surgical sessions (one session is needed for the use of RFA and the second one is for cardiac pacemakers) will take place and be financial burden for the health care system. To solve this issue, it was recommended to combine RFA with implanted cardiac devices and perform them at the same time. The use of simultaneous RFA with implanted cardiac devices leads to cost-savings. For example, in the USA, at Karolinska Hospital, Jensen and co-workers studied 50 patients with drug-resistant AFib who received RFA of the Atrioventricular junction. The investigators found that the majority of patients (about 88 %) reported improvements in their health condition. In parallel, there was reduction in the number of days in hospital from 17 to 7 and in antiarrhythmic medications' costs (by 75%). Jensen and colleagues state that the ablation is a cost-effective intervention, and if we compare the reduction in drugs' costs and in days staying at hospital with the cost of RFA and the implantation of pacemakers, we achieve breaking after 2 years [11]. Nevertheless, at the moment, in Kazakhstan, it is not reimbursed in DRGs, so that these two procedures are still performed separately.

Regarding RFA's potential safety issues, attention should be paid to some interactions between RFA and cardiac implantable devices (CIEDs) and post-operative complications. The interactions include electromagnetic interference (EMI) oversensing and inappropriate sensing; (2) transvenous lead dislodgment and others. With this in mind, it is advised to follow precautionary measures. For example, to avoid defibrillator therapy and oversensing, there is a need for programming the patient's cardiac devices prior to the ablation procedure [25].

In relation to post-operative complications, there might be such possible complications as bleeding, thromboembolism, and the pacemaker syndrome, but they are rare and occur in 3-5% of cases. Also, before going to RFA, it is highly important to take into consideration contraindications to the procedure. The procedure is not recommended for people with chronic renal failure, uncontrolled arterial hypertension, severe coagulopathy and anemia, and the decompensation of heart failure [1]. When comparing RFA with CM, there is still some uncertainity regarding the long-term efficacy and safety of CM for the maintenance of sinus rhythm [13]. That is to say, the safety issues of CM have not been sufficiently studied yet.

Kazakhstan specific studies on psychological and ethical aspects of RFA were not found. From the societal implications, the use of RFA, to some extent, improves quality of life in cardiac patients and patients can be discharged from the clinic in 2-3 days, whereas CM may require patients to stay in the hospital for 4 to 6 weeks for complete recovery because of its invasiveness [19, 22]. Notwithstanding, this issue needed to be considered further since quality of life is a broad concept and should be analyzed by taking into account many factors, from physical domains (for example, pain or discomfort) to environmental ones (for example, financial resources) [24].

Discussion

RFA is considered as an effective health intervention for patients with drug-resistant AFib. However, its success rates demonstrate variations as well as that of CM. The variations might be explained by the types of AFib, comorbidities and an electrophysiologist's experience in performing such procedures.

Compared with CM, RFA is minimally invasive with a good safety profile. Nevertheless, there might interactions between the ablation procedure and cardiac devices. These interactions may be avoided if precautionary measures are used before the procedure. This makes RFA generally safe. However, not all patients can undertake it; the procedure has its contradictions. In other words, before a patient goes to RFA, a medical examination is needed to make sure that RFA will work well for the patient and any health risks are minimized.

RFA was better than CM since it contributed to a fast recovery and a quick hospital discharge among patients. Thus, the patients can return to their normal lives in a short time On the one hand, it facilitates improvements in quality of life in some way and demonstrates RFA's superiority over CM in terms of clinical outcomes. However, on the other hand, the fast recovery and the quick hospital discharge cannot be used as a main indicator of improving the quality of life. The quality of life, by its nature, is a very subjective measure of patients' well-being and requires a multi-dimensional assessment. The statement on the positive impact of RFA on quality of life still remains uncertain. We cannot make the right judgements in support of the health technology by relying only on these two implications.

RFA with implanted cardiac devices has a potential to be cost-saving in terms of hospital resources due to reduced hospital stay and no need for additional anaesthetic supplies. In addition, RFA is cost – effective as the first-line treatment for younger patients (aged < 50) rather than older ones (aged 50 and older). However, the cost-effectiveness of RFA is mentioned in the context of the international studies. The studies were taken into consideration because any Kazakhstan-specific studies on the cost-effectiveness of RFA have not been found. Therefore, we could not totally extrapolate these studies' findings to Kazakhstan.

All results given in the review article can be considered as relevant because the strict inclusion criteria were used to make the right judgements about RFA and CM. To assess the effectiveness of RFA, we tried to include studies with the highest quality evidence: systematic reviews, meta-analyses and RCTs. Nevertheless, there are several limitations that have been found in the current studies such as a significant heterogeneity and a shorter follow – up time period. We found the heterogeneity in the study protocols and in methodology. This marked heterogeneity means that our findings must be interpreted with caution. There is a need for further studies with a longer follow - up time period to evaluate clinical effectiveness, long term survival, complications and quality of life.

Conclusion

RFA with implanted cardiac devices is clinically effective and generally safe for the treatment of AFib in drug-resistant patients. Also the health technology is potentially cost - effective and resource-saving for hospitals. Nonetheless, its clinical effects and economic implications in the long turn should be further investigated.

Conflicts of interest

The authors have no conflicts of interest to declare.

The article is original, has not already been published in any other journal.

Authors contributions

Zhandos L. Salpynov was responsible for the type of the study, data collection and its interpretation, and took the lead in writing the article.

Kamilla K. Gaitova, Adlet B. Tabarov, and Zaid K. Zholdassov participated in drafting the article and revising it critically.

Tanja Novakovic and Mark Parker helped with data collection and did a final proofreading.

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