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Study to determine radiologic medical device maintenance and repair costs: Case of a university hospital in Turkey

Radyolojik tıbbi cihaz bakım ve onarım maliyetlerinin belirlenmesine yönelik çalışma: Türkiye'deki bir üniversite hastanesi örneği

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ABSTRACT

Objectives: Unperformed maintenance and repairs cause medical devices to become idle or unusable before their useful life. In this study, the maintenance and spare parts expenditure data of a large number of medical imaging devices were comprehensively analyzed in order to determine the required expenditure values. **Methods**: In the study conducted on nearly 30 medical imaging devices of a university hospital, firstly, the economic life of the devices was determined depending on the intensity of use. It was determined that the expenditures changed in the first five years, the second five years and after the economic life. Expenditures were categorized according to the period and technological level. **Results**: According to the results obtained, the annual expenditure of medium technology devices varies between 2% and 7% of the current price. For high-tech devices, expenditures vary between 4% and 13%. In the study, the required expenditure rates for the devices according to the technology level were also predicted. **Conclusions**: It has been determined that the maintenance and repair practices of imaging devices in health institutions in Turkey are inadequate. Managers should closely monitor the inventory of medical imaging devices for effective use, quality service delivery and employee health

ÖZ

Amaç: Yapılmayan bakım-onarımlar, tıbbi cihazların kullanım ömürlerinden önce atıl veya kullanılamaz hale gelmesine neden olmaktadır. Bu çalışmada çok sayıda tıbbi görüntüleme cihazının bakım ve yedek parça harcama verileri kapsamlı bir şekilde incelenerek, olması gereken harcama değerlerinin belirlenmesi amaçlanmıştır. **Yöntem**: Bir üniversite hastanesinin 30'a yakın tıbbi görüntüleme cihazı üzerinde yapılan çalışmada öncelikle cihazların kullanım yoğunluğuna bağlı olarak ekonomik ömürleri ortaya konmuştur. Harcamaların ilk beş yıl, ikinci beş yıl ve ekonomik ömür sonrası değiştiği tespit edilmiştir. Harcamalar dönem ve teknolojik seviyeye göre kategorize edilmiştir. **Bulgular**: Elde edilen sonuçlara göre, orta teknolojiye sahip cihazların yıllık harcaması cari fiyatın %2'si ile %7'si arasında değişmektedir. İleri teknolojiye sahip cihazlar için ise harcamalar %4 ile %13 arasında değişmektedir. Çalışmada teknoloji düzeyine göre cihazlar için yapılması gereken harcama oranları da öngörülmüştür. **Sonuç**: Türkiye'deki sağlık kuruluşlarının görüntüleme cihazları bakım ve onarım uygulamalarının yetersiz olduğu tespit edilmiştir. Yöneticiler etkin kullanım, kaliteli hizmet sunumu ve çalışan sağlığı için tıbbi görüntüleme cihaz envanterini yakından takip etmelidir.

INTRODUCTION

In the present day, hospitals have become businesses where technology is used intensively as well as labor intensively. Medical devices are one of the areas where technology is used extensively in hospitals. A significant part of healthcare production is now carried out with the help of these devices. While their deficiencies hinder the provision of health services, purchasing more than needed in terms of quantity and quality leads to inefficient use of resources. The most important priority for organizations when purchasing devices is the advantageous price offer. However, the lowest-priced device with the desired technical specifications may not always be the most suitable device for the institution. It is also recommended to pay attention to parameters such as durability of the device, frequent malfunctions, immediate access to service for repair and maintenance, and adequate training and certification of service personnel (Ozer et al., 2016; Soylular & Esatoğlu, 2020; Turkish Court of Accounts, 2005).

Maintenance and repairs that are not performed cause medical devices to become ineffective or useless before their useful life. It is stated in the literature that clinical engineering departments will make serious

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contributions to the development of effective medical device use in hospitals and to increasing their efficiency (Bektemur et al., 2018a). Another study states that preventive maintenance and repair services provided by experts increase the useful life of the device by up to 30% and reduce costs (Selvi, 2009). For this reason, it is recommended that organizations document the conditions of maintenance and repair services with the help of their expert personnel during the procurement phase in order to avoid problems during the usage process (T.C. Ministry of Health, 2019).

This is especially important for the use of medical imaging devices. Imaging devices, which are generally high-tech and expensive, have a predetermined economic life. At the end of the economic life of the device, there may be a decrease in image quality and safety problems may arise for the healthcare personnel using it. In a study conducted by the European Society of Radiology (ESR, 2014), it is stated that imaging devices over 10 years old should be planned to be renewed because they lag behind technological developments, and it is difficult to obtain spare parts. Actual costs will only become apparent when a maintenance and repair specification is created that includes the required requirements. Low maintenance and repair expenses may increase the initial purchase price of the device. Or it may lead to the lack of proper maintenance. High maintenance charges may result in no maintenance at all due to lack of budget. Therefore, in both cases, the device may be out of service before the end of its economic life (Soylular & Esatoglu, 2020).

Purpose of the study

In this study, it is aimed to determine the maintenance and repair fee limits of medical imaging devices. In order to achieve this objective, the following sub-objectives were sought to be answered:

- What is the economic life of the devices?
- How much are the spare parts and maintenance expenditures of the devices?
- Do the total maintenance and repair expenditures of the devices change over the years?
- What is the most appropriate maintenance and repair amount according to the current values of the devices?

MATERIALS AND METHODS

Pamukkale University Hospitals with 853 beds were selected for the application. The hospital performs around 40 thousand surgeries annually, cares for 1.5 million outpatients and provides inpatient treatment to 65 thousand patients. During all these processes, 380 different types of medical devices are used. In the radiology department, nearly 30 high-tech imaging devices are used, which take 600 thousand images per year.

The maintenance and repair of the devices, which can be done with the hospital facilities, is the responsibility of 7 biomedical technicians working in the Biomedical unit. This unit also contacts companies for transactions that are not performed within the hospital's facilities and ensures that the work is carried out in accordance with existing contracts. At the same time, it takes part in the preparation of the technical specifications for the purchase of new medical devices.

The scope of the study was determined as the medical imaging devices of the relevant hospital. In this context, firstly, the relevant device inventory of the hospital was extracted from the Hospital Information Management System (HIMS). The economic life of these devices has been determined by researching international studies and reports. The number of years each existing device has been in use, retrospective maintenance and repair expenditures were obtained from the HIMS entries of the relevant companies and the biomedical unit.

When the maintenance and repair conditions of the relevant hospital were examined, it was seen that the technical specifications were prepared according to the part-inclusive system. Therefore, most of the spare part replacement data were obtained from the relevant companies. Since most of the contractor companies import spare parts from abroad, the current values of the prices in foreign currency were extracted. The maintenance and repair conditions of similar hospitals, especially the relevant hospital, were examined. In addition to the data obtained from here, in line with the expert opinions of the hospital biomedical unit manager, health personnel using the devices and managers, the maintenance and repair conditions that should be post-warranty in medical imaging devices were evaluated in line with the determined sub-objectives.

RESULTS

The literature on the lifespan of medical imaging devices was reviewed to better understand the current situation in the hospital. In a study by the Canadian Association of Radiologists (CAR, 2013) found that the lifespan of imaging equipment varies according to intensive, normal and low-intensity use. According to the study, Angiography, C-arm Scopy, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) devices have a lifespan of 8-12 years, Mammography 8-10 years, and Ultrasonography 7-9 years. Intensive use represents 24 hours x 5 days per week or 750 shifts of 8 hours per year. Normal use represents 16 hours x 5 days per week

or 500 shifts of 8 hours per year. Low-intensity use represents 8 hours x 5 days per week or 250 8-hour shifts per year. CAR also provided medical imaging devices lifespan information based on international guidelines, literature review and surveys/interviews with experts. A guiding table was created by examining the equipment used by experts from various fields, financial situations, maintenance histories and technological development. The data are shown in Table 1.

The classification stated by CAR in its report is also included in the ESR study, and it is stated that in addition to these conditions, the age of the device cannot be the only valid factor for use, and software and hardware updates will be required in order to use the existing equipment in accordance with the latest technology. It is also stated in the study that up to the age of 5, imaging devices are considered compatible with the current technology, and the updates and maintenance needed for those aged 6-10 should not be interrupted (ESR, 2014).

According to the Life Expectancy Guideline of the Florida Department of Revenue, the lifespan of all equipment in the hospital is determined as 10 years (Florida Department of Revenue, 2015). In Turkey, the useful life of medical devices is specified in the fixtures section of the annex of "Depreciable Economic Assets" of the General Communiqué of the Tax Procedure Law. In general, medical devices have a useful life of 10 years (Official Gazette of the Republic of Turkey, 2004).

In line with the life expectancy assessments obtained in the study, the imaging device inventory of the hospital was analyzed. When the examples given above are evaluated collectively, the life expectancy of imaging devices can be accepted as 8-12 years. However, in order to be more determinative, the CAR study, which determines the economic life according to the intensity of use, was taken into consideration and the number of imaging of radiological devices in the hospital was calculated (Table 2). In order for the study to serve as an example for institutional managers, the intensity of use of imaging devices in Turkey and internationally was also investigated. Turkey ranks first in the Organisation for Economic Co-operation and Development (OECD) ranking with 12,462 images per MR device in 2020. In CT devices, it ranks second with 18,116 imaging (OECD Stat, 2022; Republic of Turkey Ministry of Health, 2022). In the report published by CAR, the intensive use of CT devices is more than 15.000 imaging per year, while the same number is over 8.000 for MR devices (CAR, 2013). Both the Turkish average and the number of device imaging in the relevant hospital are much higher than international examples. As a result, the economic life of imaging devices is predicted to be 8 years at most. However, since it is not easy to renew expensive

Table 1. Medical imaging devices lifespan information (CAR, 2013)

Device type	CAR (2013) †	US army (2011)	UK royal college of radiologists (2012)
Radiography general	10-14	8-12	10
Fluoroscopy	8-12	10	7
Interventional	8-12		7
C-arm mobile	8-12	8	
Angiography (single/double plan)	8-12		7
CT	8-12	8	7 ‡
MRI	8-12	5	7 ‡
Ultrasonography	7-9		5
Mammography	8-10	10	

† Lifespan is based on usage within the given range and should not exceed 15 years.

‡ The state budget is based on replacing devices every 10 years, while the national audit report forecasts a 7-10 year interval for device replacement

imported devices with low healthcare prices that do not even cover the costs under Turkish conditions (Kara et al., 2015), it was found correct to use the economic life of medical imaging devices as 10 years in the study. Pamukkale University Hospitals Radiology medical device park contains 27 devices, including those that have been decommissioned but can be commissioned in case of failure of other devices and those that have not yet been scrapped. Most devices (55%) exceed the above-mentioned economic lifetime limits. Again, most devices exceed the high-intensity usage limits specified by CAR. Three devices were used at medium intensity, while only three devices were used at low intensity. The data are given in Table 2.

Spare parts expenditures

In the rest of the study, hospital data on spare parts expenditures were analyzed. Regardless of whether there is a maintenance agreement or not, the spare part replacement and repair expenditures for the devices were taken from the companies. If the expenditures are in foreign currency, the amount was taken in the same way, and if it is in Turkish Liras, the current values were extracted according to the changes in foreign currency. From the first results, it was observed that there was no spare part expenditure that would create a significant value in the Ultrasonographies, except for the probe repair, so these devices were excluded from the scope.

The Coordination Committee of the European Radiological, Electro-medical and Health Informatics Industry (COCIR) has updated its previously published report on the profiles of medical imaging devices in Europe in 2019. The report examines the age and density of medical imaging devices by country and device type. The review is carried out according to the "Golden Rules" set by the committee. Accordingly, devices up to

Table 2. Pamukkale University Hospitals radiological device inventory

Device description	Purchase date	Usage date/Period	Economic lifetime	Average number of imaging per year
Angiography	07.12.2006	Active-16 years 0 months	Expired	3,268 ‡
Angiography	12.12.2012	Active-10 years 0 months	Expired	3,983 ‡
CT	23.11.2011	3.11.2021-10 years	Expired	23,347 ‡
CT	24.02.2022	Active-0 years 10 months	Non-expired	New Device
CT	18.03.2009	12.11.2021-13 years	Expired	37,305 ‡
CT	3.12.2018	Active-4 years 0 months	Non-expired	Unreachable
Doppler US	19.02.2021	Active-1 year 10 months	Non-expired	6,280 ‡
Doppler US	19.02.2021	Active-1 year 10 months	Non-expired	6,327 ‡
Doppler US	22.11.2011	Active-11 years 1 month	Expired	Unreachable
Doppler US	16.11.2012	Active-10 years 1 month	Expired	7,310 ‡
Doppler US	28.01.2010	Active-12 years 11 months	Expired	11,745 ‡
Ultrasonography	4.09.2012	Active-10 years 3 months	Expired	10,565 ‡
Ultrasonography	25.11.2011	Active-10 years 1 month	Expired	9,065 ‡
Doppler US	7.12.2012	Active-0 years 1 month	Non-expired	New Device
Fluoroscopy	18.03.2009	9.11.2022-13 years	Expired	1,444
Fluoroscopy	10.11.2022	Active-0 years 1 month	Non-expired	New Device
Mammography	3.10.2016	Active-6 years 2 months	Non-expired	2,983
MRI	6.12.2006	25.11.2022-15 years	Expired	20,756 ‡
MRI	13.05.2014	Active-8 years 7 months	Non-expired	21,317 ‡
X-Ray	16.03.2009	Active-13 years 9 months	Expired	15,420 †
X-Ray	18.02.2009	Active-13years 10months	Expired	23,863 ‡
X-Ray	25.12.2013	Active-9 years 0 months	Non-expired	37,670 ‡
X-Ray	3.08.2015	Active-7 years 4 months	Non-expired	46,043 ‡
X-Ray	19.11.2012	Active-10 years 1 month	Expired	31,809 ‡
X-Ray	19.11.2012	Active-10 years 1 month	Expired	11,966 †
X-Ray	11.03.2014	Active-8 years 9 months	Non-expired	2,557
X-Ray	11.03.2014	Active-8 years 9 months	Non-expired	13,545 †

Table 3. Spare parts expenditures by device type and period

Period / Device type	Year	Spare part expenditures-₺	Number of devices (n)
First period first phase (Warranty coverage)	**0-2**	**1,103,934**	**19**
Angiography		792,817	
CT		311,116	
First period final phase	**3-5**	**8,286,246**	**17**
Angiography		1,829,841	
CT		2,044,113	
X-Ray		419,580	
MRI		3,992,711	
Second 5-year period	**6-10**	**13,316,059**	**16**
Angiography		3,411,636	
CT		3,242,941	
X-Ray		463,050	
Fluoroscopy		340,200	
Mammography		264,600	
MRI		5,593,632	
Post economic lifetime period	**10+**	**14,098,192**	**7**
Angiography		3,201.134	
CT		1,077,856	
X-Ray		189,000	
Fluoroscopy		548,080	
MRI		9,082,121	
Overall total		**36,804,432**	

5 years old reflect current technology and should make up at least 60% of the current inventory. The proportion of devices between 6-10 years of age for which system change plans have been initiated should be at most 30%. The number of devices over 10 years old, which are outdated and increasingly costly and difficult to maintain/repair, should be at most 10% of the total (Denjoy, 2016).

In the study, spare parts expenditures are divided in three parts according to the COCIR "Golden Rules". In addition, the scope of warranty, which does not create any cost for the institution, is also indicated in the table. During this period, all maintenance and repairs of the device are covered by the contractor company and its duration is two years. The results (Table 3) obtained show that the period when the spare parts expenditures of medical imaging devices are the highest is the period when they exceed 10 years of use and reach the end of their economic life, as expected. The table shows that the maintenance and repair cost expenditures of medical imaging devices are the lowest in the first 5 years. In addition, expenditures per device vary according to the year of use. This situation does not create a significant difference between the first and the second five-year period in the annual average. However, the number of devices decreases by more than half in the post-economic life period. Therefore, while 8 million₺ was spent with 17 devices in the first period, 14 million₺ was spent for the spare parts of 7 devices in use after 10 years. This situation shows that the actual change is much higher.

Determination of maintenance and repair limits

In the light of the information given, in order to obtain the most realistic and consistent maintenance and repair limits of medical imaging devices, in addition to the spare part expenditures obtained from the companies, the annual maintenance fee was added. This amount was accepted as 2% of the current device cost for the 'first five-year period', 3% for the 'second five-year period' and 4% for the 'post-economic life period' in accordance with the relevant hospital and Public Procurement Platform examples. No maintenance fee was charged for all devices within the two-year warranty period. Current device prices were determined with the help of expert opinion and recent purchases of the Public Procurement Platform. The current prices of technologically outdated devices were determined by considering similar devices in line with the market segment in the year of purchase. Expenditures for spare parts purchased from companies were determined in Dollars or Euros since most of the devices are manufactured and imported abroad.

Expenditures stated in Turkish Lira have been converted into foreign currency according to the exchange rate value in the relevant period. All expenditures were classified periodically and finally converted into Turkish Lira according to the current exchange rates. The results obtained are given in Table 4.

Two X-ray devices for which spare part expenditure data could not be obtained were excluded because the remaining six devices were deemed sufficient for the study. In the next stage, the ratio of the annual maintenance and repair cost to the current device price was determined. For this process, the expenses classified according to the device type and periods were divided by the usage year and the current device price. A calculation example is given below.

Period1_Angiography = (2,594,600+1,049,641) / (15,120,000 + 15,120,000) / 3

According to the results, although the number of devices decreases as the period progresses, expenditures increase in the total of maintenance and spare parts. In addition, expenditures vary according to the device type. The total expenditure on relatively inexpensive devices such as X-ray, Fluoroscopy, and Mammography is also low. Expenses are high for devices such as MRI, Angiography, CT. This state should be taken into account when making annual maintenance agreements. A maintenance and repair fee should be determined in proportion to the price and type of the device.

In the light of the information obtained, the annual average expenditure changes of the first (first 3 years after warranty), second (between 6-10 years) and third (after economic life) period according to the device type are given in the chart below. Accordingly, average annual expenditures increase in all device types as we move to the next period. The only exception to this is that the third period of the CT device is less than the second period. However, only one of the four CT devices in the hospital reached the third period (over 10 years), which led to this situation. If the other three devices reach beyond 10 years, the curve is expected to be like the other device types. Expenditure changes are shown in Figure 1.

Table 4. Total periodic spare parts and maintenance expenditures

Device	Use year	Device current value (₺)	Maintenance price (₺)	Spare part + maintenance price (₺)	Period of 3 years after warranty (₺)	Second 5 years period (₺)	After economic lifetime (₺)
Angiography	16	15,120,000	6,804,000	14,774,313	2,594,600	5,349,780	6,829,934
Angiography	10	15,120,000	3,175,200	3,647,498	1,049,641	2,597,857	0
CT	10	4,725,000	992,250	5,009,598	1,836,308	3,173,290	0
CT	1	10,395,000	0	0	0	0	0
CT	13	10,395,000	3,430,350	5,286,608	623,700	2,337,651	2,325,257
CT	4	10,395,000	415,800	907,106	907,106	0	0
Fluoroscopy	14	4,158,000	1,538,460	2,426,740	249,480	963,900	1,213,360
Fluoroscopy	1	4,158,000	0	0	0	0	0
Mammography	6	6,048,000	544,320	808,920	362,880	446,040	0
MRI	15	19,845,000	8,136,450	22,691,840	3,882,301	5,758,417	13,051,122
MRI	9	19,845,000	3,572,100	7,685,176	2,491,811	5,193,365	0
X-Ray	9	1,228,500	221,130	296,730	73,710	223,020	0
X-Ray	7	2,835,000	340,200	907,200	548,100	359,100	0
X-Ray	10	2,835,000	595,350	797,580	211,680	585,900	0
X-Ray	10	2,835,000	595,350	784,350	170,100	425,250	189,000
X-Ray	9	945,000	170,100	170,100	56,700	113,400	0
X-Ray	9	1,890,000	340,200	378,000	113,400	264,600	0

CONCLUSIONS

In the study, radiological medical device maintenance and repair expenditure data of the relevant hospital were analyzed. In order to reach clear results, the economic lifetime of medical imaging devices was first investigated. In determining the economic lifetime, many national/international associations, institutions, unions and army practices were examined. In addition, considering the device usage intensity recommended by CAR, the number of imaging of radiological devices in international, Turkish and related hospitals were calculated. As a result of all these examinations, we recommend that the economic lifetime of imaging devices in Turkey should be accepted as 10 years.

The next step was to extract retrospective spare parts and maintenance expenditure data for the medical imaging devices of the relevant hospital. The data were evaluated by dividing into periods according to the imaging device profile standards set forth by COCIR. The change in expenditures can be seen more clearly in spare parts. The expenditures incurred in third period of the devices are 50% more than the expenses incurred in the first 5 years, including the warranty. It should also be considered that the figure in the third period, representing more than ten years of use, consists of one-third of the total number of devices. The data is also similar for total expenditures including maintenance. In conclusion, the most productive period of medical imaging devices in terms of cost effectiveness is the first five years. The most inefficient period in terms of cost is more than 10 years when they reach the end of their economic life.

According to the data obtained in the study, the spare parts expenditures of medical imaging devices with advanced technology (MRI, Angiography, CT) vary between 2-11% of the device price per year, while the expenditures of other devices that can be evaluated as having medium technology (X-ray, Fluoroscopy, Mammography) vary between 1-4%. In the study of Temple-Bird et al. (2005), it is stated that spare parts budget planning should be done for 2 years, 20% for high technology devices and 10% for medium technology devices. Considering that budget planning should be done according to the highest possible values, the results are in line with our study.

In another study that draws attention to the spare parts expenditures of medical devices, the data obtained from the Business Intelligence Decision Support System of the Republic of Turkey Ministry of Health were examined. For this process, medical devices used in six different public hospital associations in Istanbul were evaluated. As a result, it is stated that the annual spare part expenditures of the device group containing medical imaging devices vary between 1.66% and 4.69% of the device price (Bektemur et al., 2018b). These results are in accordance with the spare parts expenditures of the devices with medium technology in our study.

In the study, total expenditures on maintenance and spare parts were also evaluated in two parts. The annual expenditure of mid-level technology devices consisting of X-Ray, Fluoroscopy and Mammography varies between 2% and 7% of the current price of the device. Taking into account the averages, we recommend that the required maintenance-repair value be considered as 3% for the first period (first 3 years after the warranty), 4% for the second period between 6-10 years, and 6% for the third period over 10 years. In the Angiography, CT and MR group, which has advanced technology and consists of more expensive devices, expenditures vary between 4% and 13%. Considering the averages, we recommend that the required maintenance-repair value be considered as 5% for the first period (the first 3 years after the warranty), 6% for the second period between 6-10 years, and 8% for the third period over 10 years. It should be taken into consideration that the data obtained are prepared according to the list prices of the companies. Another point to be considered is that the expenditures include large parts such as tubes, detectors, and coils.

In the study of Temple-Bird et al. (2005), it was stated that an expenditure of between 5% and 6% of the new acquisition cost is required each year for the maintenance and repair of medical devices. However, in the same study, it is stated that different applications are made depending on the local conditions of different countries. For example, the East African Health Technology Administration stated that it would be more beneficial for maintenance and repair fees to vary between 6% and 10% of the new acquisition cost to cover local labor costs. Sri Lanka Ministry of Health stated that the cost of maintenance should vary according to the age of the device. Accordingly, 2-3% of the acquisition cost of the device for the first four years, 4-6% for 5-6 years old devices and 7-8% for 7-10 years old are determined. These results seem to be compatible with the findings of our study.

In order to reveal the implementation of the spending limits in Turkey, X-Rays, Computed Tomography, Magnetic Imaging and similar medical imaging device maintenance and repair specifications belonging to the institutions for the last 5 years were examined from the website of the Public Procurement Authority. Public institutions in Turkey generally set a price between 2-4% excluding parts and 4-8% including parts. In the specifications, high-cost parts such as tubes and detectors are generally excluded from the calculation,

but upper limits such as 8-15 percent, including all spare parts, are also set. Only one institution's specification takes into account the change in maintenance and repair expenditures over the years. However, this value remains below the fixed rates determined by other institutions (Electronic Public Procurement Platform [EPPP], 2022). When the results of the study are compared with these examples, it is seen that current institutional practices do not differentiate according to device type. In general, a fixed maintenance and repair specification is tried to be applied for all devices on an institutional basis. In addition, the periodic differentiation according to the year of use of the device, which is also clearly seen in the results of the study, is not taken into consideration in the specifications. Current practices across Turkey are inadequate.

In the literature, there is very limited information on the maintenance agreements of medical devices, which are of great importance for the provision of healthcare services in hospitals. This study, which we think will be helpful for hospitals and companies in determining the maintenance and repair conditions of post-warranty medical imaging devices, has contributed to the literature. Of course, it is possible for hospitals to follow the procedures consciously by utilizing this study only with the joint work of management, user healthcare personnel and biomedical engineering.

It should be kept in mind that the data in the study is according to the conditions of Turkey and the research is dependent on the medical imaging devices of only one hospital. The high determination of the device economic lifetime due to low healthcare fees and the renewal of expenditures according to the current exchange rate in the front of increasing foreign exchange reflect this feature of the study. In a regional or Turkey wide study with data from the Ministry of Health, more precise results can be obtained by obtaining a large amount of data from all device types for each period of use.

In addition to the procurement process of devices, health managers should closely monitor the inventory of medical devices for reasons such as preventing harm to personnel, using limited financial resources effectively, and providing quality healthcare services. In particular, the economic life of radiological devices and the number of imaging that can be taken within this life should be determined, and maintenance and repair conditions should be written in the specifications. It should be clearly stated how many maintenances will be performed per year, how much the maintenance fee will be, which spare parts will be included in the maintenance contract and which will not, and what their fee will be.

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