Application of Artificial Intelligence in Magnetic Resonance Imaging:Implementation of a Healt Technology Assessment (HTA)

C. Curatolo¹, G. Faraci², D. Graceffa³, S.A. Distefano⁴, D. Salvaggio⁵, G. Lo Re⁶

1. Specialist MRI, Dipartimento di Diagnostica per immagini, A.O.U.P. "P. Giaccone", Palermo

2. Dirigente Prof.Sanitarie Tecniche Diagnostiche, ASP 4 Enna

3. MSc, Dipartimento di Biomedicina, neuroscienze e Diagnostica Avanzata,Università di Palermo

4. Docente a Contratto, PTA Dipartimento Promozione della Salute, Materno-Infantile, Med. Int.e Specialistica di Eccellenza "G.D'Alessandro"

Università di Palermo

5. Dirigente Ingegnere, UOC A.O.U.P. "P. Giaccone", Palermo

6. Professore Associato, Sezione di Scienze radiologiche, BIND, Università degli Studi di Palermo

* Corresponding author: E-mail address: calogerocuratolotsrm@hotmail.it

KeyWords:

HTA, MRI, Artificial Intelligence, Deep-Learning, Machine Learning, Temporal Resolution.

ABSTRACT

The implementation of Artificial Intelligence (AI) in Magnetic Resonance Imaging (MRI) represents a significant innovation in the healthcare sector, with potential benefits in terms of both efficiency and diagnostic quality. This study conducted an analysis through a Health Technology Assessment (HTA) model to evaluate the impact of AI on 1.5 T and 3 T MRI scanners, focusing on the reduction of examination acquisition times. The results show a cost-benefit ratio that justifies the investment due to a quick economic return and an increase in departmental productivity. The rise in MRI exams performed contributes to the objectives of Radiology units and hospital management to reduce waiting lists. Furthermore, AI enhances image quality, reducing artifacts and noise, providing superior diagnostic support, and allows for a broader patient base, as faster exams are better tolerated by less compliant patients. Our model thus highlights the numerous advantages of adopting AI in MRI, emphasizing its relevance to the regional and national healthcare system, and its ability to meet the objectives of the Italian National Plan 2024-2026 for improving healthcare services.

INTRODUCTION

Any healthcare system might optimize economic resources towards effective and safe technologies and treatments that adopt scientific advancements and innovation while maintaining economic sustainability. Health Technology Assessment (HTA) is one of the tools capable of guiding decisions towards this virtuous goal [1,2]. HTA is the "multidisciplinary process that synthesizes information on clinical, economic, social, and ethical issues related to the use of a health technology, in a systematic, transparent, impartial, and robust manner" [3,4]. In recent years, among the health technologies employed in imaging diagnostics, Magnetic Resonance Imaging (MRI) has experienced rapid developments, including the implementation of Artificial Intelligence software. We have therefore conducted a hypothetical Health Technology Assessment model on the application of Artificial Intelligence to MRI equipment, identifying numerous potential advantages, including the optimization of image quality, reducing or eliminating artifacts, supporting radiologists in detecting specific pathologies or anomalies, and especially reducing acquisition times for individual exams. This last potential advantage addresses two types of needs: one related to the patient shorter exam duration leads to greater compliance and one related to the healthcare system as a whole more exams per MRI session contribute to reducing waiting lists, a key objective of the National Plan 2024-2026.

This study aims to design a comparison model within the framework of Health Technology Assessment (HTA) between MRI scanners currently in use without the application of AI and the same scanners with potential AI implementation, with the goal of evaluating the impact that such implementation would bring. This model requires the analysis and comparison of various factors to achieve a comprehensive understanding of the issue [5].

To do this, it was necessary to analyze several parameters:

- Costs: the microeconomic level in terms of reimbursement, DRG, purchase, maintenance, and installation; the macroeconomic level in terms of impact on the national healthcare economy, specifically the cost of the exam.
- Effectiveness: evaluation of the differences between MRIs with AI and MRIs without AI in various clinical applications, and assessment of Spatial Contrast Resolution with a focus on Temporal Resolution [6-7].
- Efficiency: evaluation of the benefit/cost/time ratio of the MRI exam.
- Social Impact: patient tolerance in terms of

1



RESEARCH ARTICLE

Citation:

C. Curatolo et al. "Application of Artificial Intelligence in Magnetic Resonance Imaging: Implementation of a Healt Technology Assessment (HTA)"

JAHC 2024 Vol 6 - 3

Received: 2024-09-13 Revised: 2024-09-16 Accepted: 2024-10-20 Published: 2024-10-21



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/ licenses/by/4.0/).

Year 2024 - Volume 6 Issue 3

MRI exam duration.

Five parameters were also defined, based on which a baseline model was determined. Specifically, the analyzed criteria included:

- Cost of AI in the market (average cost among the main vendors)
- Image quality

2

- Degree of tolerability of an exam
- Acquisition time for individual exams
- Number of exams per session

The final objective is to develop a HTA evaluation model for AI applied in MRI scanners, which can effectively support healthcare organizations in identifying and evaluating technologies that maximize patient benefits, as well as advantages for the healthcare system, the economy, and society as a whole. In evaluating economic aspects, in accordance with the HTA model, we will subsequently detail:

- Preventive spending with a breakdown of costs

- Benefits in terms of output, outcomes, clinical effectiveness, and served patient base

- Cost analysis, including potential annual savings and economic impacts on other services

MATERIALS AND METHODS

Analysis of preventive spending and cost-effectiveness

Several papers were collected where the main costs (average-list cost of major vendors) regarding the implementation of AI on 1.5T and 3T equipment were analyzed. The prices are indicative as they may vary mainly due to the greater complexity of the algorithms applied to manage the acquired data (the 3T has a greater amount of acquired data compared to the 1.5T), type of AI system required (more sophisticated features and algorithms require higher prices); costs may vary according to the level of customization and integration required to adapt the AI solution to the specific needs of each hospital, integration with existing RIS/PACS systems may incur additional costs, and finally, the request for additional services such as training, support, and upgrades may require additional cost [8-10].

In summary, the ranges shown (Tab.1) reflect the variability in the market and the need to carefully assess the specific needs of each healthcare organization.

Fig.1 shows the remunerations provided for different types of MRI examinations in the tariff schedule of Sicily Region (2024)

Tab.1 Prices referring to the AI cost of major vendors according to a report by "Signify-Research" (ed.2022) are given. Costs are indicative and may vary based on multiple factors

VENDORS PRICES									
	IA	Assurance	Technical Support and Maintenance	Technical Staff Training					
1.5 T	150.000-250.000	20.000-35.000	20.000-35.000	10.000-20.000					
1.5 T	160.000-260.000	22.000-37.000	22.000-37.000	10.000-20.000					
1.5 T	150.000-280.000	15.000-25.000	10.000-20.000						
1.5 T	170.000-270.000	15.000-20.000	15.000-20.000	5.000-10.000					
3.0 T	200.000-300.000	25.000-40.000	25.000-40.000	15.000-25.000					
3.0 T	220.000-320.000	27.000.42.000	27.000.42.000	15.000-25.000					
3.0 T	200.00-300.000	15.000-25.000	10.000-20.000						
3.0 T	200.000-300.000	15.000-20.000	15.000-20.000	5.000-10.000					





AL \$1012624	(set #1010834)		NOT 1	19,89	-		Branca 1	Brance 1	Brance 2 (dal 01/01/	Descrizione (del 01/01/2024)	(dal 01.01/2024	NUM.	TP_RP	-		p Branca 1	Brance 1	Branca
91.1	RICH ENCEFALO E TRONCO ENCEFALCO. GLAZIONE CRANO SPINALE E NELATIVO DISTRETTO INSCOLARE.	10.554						Dagronica per 4	88.93.6	AM DELLA COLONNA IN TOTO NUI ABBOURDE & AM DEL RACHIDE CERVICALE (M 53.2), AM DEL RACHIDE DORSALE (M 53.3), RM DEL RACHIDE LOMBOSACRALE (M 53.4), RM DEL	231 60 4	23				и	Diagnostica per t	
P12	RM DI ENCEFALO E TRONCO ENCEFALICO. GUINZIONE CRANO SPINILE E RELATIVO. DISTRICTO UNICOLARE SENZA E CON MICC.	247 51 4						Dagronica per i		RACHDE SACROCOCCIGEO (M 81.5) RACHDE SACROCOCCIGEO (M 81.5)		-	-	+ +	-			
91.5	ANGIG- RM DEL DISTRETTO VASCOLARE INTRACRANICO	194,80.4				1		Degrostica per k	48 93 7	TOTO SENZA E CON MDC (M \$3.8)	101.25 0	1 24				04	Diagnostica par s	
914	RN DEL COLLO (famige, lannige, partitid-ghanitole salvan, thode-paratitivad) inclusio relative domato valorative	120.014						Dagronita per i	88.93.8	RM DEL RACHIDE DORSALE SENZA E CON MDC. Non associable a RM DELLA COLONNA IN 1000 SENZA E CON MOC (IA 14 E)	181.25 6	1 24				04	Degrostica per il	
17	HM DEL COLLO SENZA E CON MDC (temps, semps, pantol-ghandrie salvart trolla-	167104						Depresida per 1		RM DEL RACHDE LOMBO SACRALE SENZA E CON MDC. Non associable a RM DELLA		1	-	+ +	-		Descention and a	
	Available to the second s	164.804	+ +	_	+	-		Depresities per 1		COLONNA IN TOTO SENZA E CON MDC (M 93.8)	1.01	10	-	+ +	-		Configuration for a	
	RV DE, MATECOD FACCIALE Managia mandhosa cauta nauti, kan panamasi, emutiki			-		_	-		48.93 A	COLONNA IN TOTO SENZA E CON MOC (M 33.8)	181.25 6	1 24				08	Diagnostica per i	
C. 1. 1	Incluse: wielvo datretto vasculario. Non associados a FM DELL MITCOLAZIONE							100	88.93.8	FM DELLA COLONNA IN TOTO SENZA E CON MDC. Non associable a 68.93.7, 88.93.8,	361.50 4	25				08	Disprostica per il	
·	TEMPORONANDISCLARE MONOLATERALE E/O BLATERALE (M PLB), RM DELLA SELLA TURICICA (M M C), BINTRULE ROCCHE DETRONE (M M T), BN TRULE OBRITE (M M D), A	50104						Degrafia per i	MALC	IN SUS IN SUA	181 25 4	-	-	+ +	-		Discoverics per a	
	RIFORLI, MITCOLAZIONE TEMPORONINADIOCLARE MONOLATERIALE E/O BLATERIALE Incluso: relativo distrutto esseniaria incluso exerciante marria dinarrocci. Non associabile a RIFORLE.								10.54	ARTRO RM Incluso: asame di base. Per distrato articolare. Non asaocabile a ARTROGRAFIA	136.65.4				-		Diagonatica par à	
	MASSICCIO FACCIALE (IN VIA) HIN DELLA SELLA TURCICA (IN VIC), HIN DELLE ROCCHE	120-054						Desprimitive per k		CON MDC (M.32) e a RM del detretto articolare interessato		-	-	+ +	-		Despendence por t	
	COMPLESSING (M.RT.F)		\rightarrow		-	-				RM DEL BRACCIO Incluse part woll, delively vessione	116.834	24	-	+ +	-	08	Diagrostica per i	_
	RM DELLA SELLA TURICICA. Incluse: relative destreto vasculare Non associative a RM DEL								88.94.6	RM DEL GOMITO Inclues partimult, dezrets vasculare	115.80 €	28				04	Diagnostica per a	
2	NONOLATERALE E/O BLATERALE (M FI B), RM DELLE ROCCHE PETROSE (M FI D), RM							Degrattia per i	88.94.7	RM DELL'AVAMBRACCIO Incluso parti moli, distretto vasculare	115.804	28				08	Diagnostica per il	_
_	DELLE ORBITE (M.F.E) + RM DEL MASSICOU FACCIALE COMPLESSIVO (M.F.F.F)		+ +	_		-			85.94.8	RM DEL POLSO Incluso parti moli, distrato vasculare	115.804	28		+ +	-	08	Diagnostica per i	
	RM DELLE ROCCHE PETROEE, Indusc velative destrato velative hav associative a RM DEL Amblicition Factoria E de strais RM DELL METERO AZONE TEMPORICAMORICA ARE								10 54 5	IN DELA MARC Here and mult details section	115.80	1 2	-	+ +	+		Diagnostica per s	
9	MONOLATERIALE E/O BILATERIALE (M 91.B), RM DELLA SELLA TURCICA (M 91.C), RM	00.084						Dayruttia per i		RM DELL'ARTICOLAZIONE CONOFEMORALE MONO E/O BILATERALE, Inclusis parti multi.	115.01.0	1		+ +	-		Company of the part of	
	DELLE DARIA (MARAE) E MARAE, MARAECO PACENCE COMPLEMENTO (MERAE)		+ +	_	-	-			and and a	datetta racolare	115.64	1 2	-	+	-		Dependence per s	_
	RM DELLE ORBITE, Inclusi: Habin dishrito vanistare Non associable a RM DEL MASSICOLO. FACCIALE IM PLAL RM DELLI ARTICOLAZIONE TEMPORIOAAND/BOLARE MONOLATERIALE					1			M 14 0	BM DELCA COSCA (HA DEL FEMORE) FROM part Hon, delivero valcolare BM DELCA COSCA (Ha del FEMORE) FROM part Hon, delivero valcolare	115.824	27	-	+ +	+		Diagnostica per s	
· · ·	E/O BLATERNLE (M VI 8), RW OELLA SELLA TURCICA (M VI C), RW OELLE ROCCHE	dente						ballounce into	18.34 E	RM DELLA GAMBA Incluse: parti moli, detretto resculare	115.80 4	28		+ +	-	08	Diagnostica per 4	
	Re DD, MASSCOO FACOAL COMPLETING Bude multidential of the com		+ +		+	-			88.94.F	RM DELLA CAVIOLIA. Incluso: parti multi, distretto vasciliare	115.80 4	28				08	Diagnostica per a	_
	segment/district incluse relative districts reaccians Non association a RM 261, NA35-COD								88.94 G	AM DEL PIEDE. Inclues parti moli, detreto vascstare	115.80 4	28			-	08	Diagnostica par s	-
· · · ·	EXCERT IN FILL IN FILL IN COLLONE SUPPRISING BOLDER MORE ASSAULT	Con la c				1.1		patronia (a. r	88.94 H	RM DELLA SPALLA SENZA E CON MDC Incluse part molt, detrette vasculare	177 15 4	28	-	+	+	09	Diagnostica per s	
-	PETHONE IM HI DLA HM DELLE OMBITE IM HI EL		+ +	-	-	-			10.54 K	INV DEL BRACCIO SENZA E CON MOC. Incluso parti molt, distritto vascolare INV DEL GOMITO SENZA E CON MOC. Incluso: parti molt, distritto vascolare	177 15 4	28	-	+ +	+	08	Diagnostica per s	_
	RM DEL MASISCOLO FACCIALE SENZA E CON MEC (Maximila, manifisita, carità nasali, amigananasali, atmosfe) incluso matellos distretto vascolare, Non associabile a filli								88.94 L	RM DELL'AVAMBRACCIO SENZA E CON MDC. Inclusi: part molt, distrato vascolare	177 15 6	28				08	Diagrostica per a	
s	DELL'ARTICOLAZIONE TEMPOROMINADIBOLARE MONOLATERALE O BLATERALE SENZA E CON MERCI UN ALLA INVOLLA NULLA TURICICA NENZA E CON MERCINA EL UN DIALOGUIA	107.05.6					6 A	Degratile per h	88.94.M	RM DEL POLSO SENZA E CON MOC Incluse part molt, distrito vascolare	177.15	E 28				08	Diagnostica per a	_
	ROCCHE PETROBE SENZA E CON MOC (IN \$F.K). RM DELLE ORBITE SENZA E CON MOC								88.94.N	RM DELLA MANO SENZA E CON MDC. Incluso: parti molil, distratto vascolara	177.15	28	-		-	08	Diagrostica per i	_
	INE PLU + NE CEL NASSICCIO PACCIALE COMPLESSIVO SENZA E CON MOC (NE PLM)		+	_	-	-			MHP	RM DEL BACINO SENZA E CON MDC. Incluse part mail, detratio vascalare and pelu vastroco a trone concessional a service and a tratal a service a concessor	177 15 6	1 21	-	+ +	-	08	Diagnostica per s	
	He DELL WITCOLADRE TEMPOROMOROLARI MONOLATINALE DI BLATINALE BISÀR CON DE Indus maine Bardin sante Indus wentañ sante darrens fan anventañ a ME DEL MORICO FACOLE INDU E CON MOC (ME M 6, MEXOLA BILLA TUNICA BISÀR CON MOC (ME M), IM DELLA ROCHE PETROME BISÀR E CON MOC (ME M 6, MEROLLI ORIETTI BISÀR A CON MOC (ME M 1.1 kM 601, MARCO FACOLALI	-							88.94.Q	trobal part molt detrato vanchare	177.154	28				08	Diagrostica per i	
LIETH REMOVED & MODEL MASSICCO TURCICA MINEAE CON MOC (M IN 19 K), MINORULI ORDITE SIN COMPLETING SINUAL CON MO							in 19	Degratite per i	88.94.71	RM DELLA COSCIA (RM DEL FEMORE) SENZA E CON MOC. Incluso part mult, distrato	177 15 6	28				08	Diagrostica per i	
									88.94 5	RM DEL GINOCCHED SENZA E CON MDC. Incluse: parti moli, distritte vascolare	177 15 4	28	-	+ +	-	08	Diagrostica per a	-
	COMPLESSIVO SENZA E CON MDC (M P1 M)					-			88.94 T	AM DELLA GAMBA SENZA E CON MDC. Incluso: part molti, distritto vascolare	177 15 6	28				08	Diagnostica per i	
	HID DULA SELLA FUNCIÓN DUDA E COM MOL INITIAN INITIA DIRENTIANE NEM annualma de MO EL MARCIO FACOLE E ENDA E COM MOL INF 40, INI DELLA MILCOLADORE TRAPOROMANDOLARI MONOLATIRAL O BLATIRALE BENA E COM MOL DE H HIM INICIALI DE SOCIET PERSONNE MINA E COM MOL ME HAN MOL INITIA COM MOL DE H HIM INICIAL DE SOCIET PERSONNE MINA E COM COM HIM NO MOL INITIA COM MOL DE H HIM INICIAL DE SOCIET PERSONNE MINA E COM COM HIM NO MOL INITIA COM MOL DE H HIM INICIAL DE SOCIET PERSONNE MINA E COM COM HIM NO MOL INITIA COM MOL DE H HIM INICIAL DE SOCIET PERSONNE MINA E COM COM HIM NO MOL INITIA COM MOL DE H HIM INICIAL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA INICIAL DE SOCIET MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA INICIAL DE SOCIET MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA INICIAL DE SOCIET MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIM NO MOL INITIA INICIAL DE SOCIET MINICIAL DE LA MOL DE SOCIET PERSONNE MINA E COM HIMA E MOL MOL DE SOCIET PERSONNE MINA E COM HIMOL DE LA MOL DE SOCIET PERSONNE MINA E COM HIMOL DE SOCIET PERSONNE DE SOCIET PERSONNE DE SOCIETARIA DE S							Deputts pr 1	88.94.U	RM DELLA CAVIGLIA SENZA E CON MOC. Incluso: part molt, distritto vascolare	177.154	28				- 08	Diagnostica per a	_
81.2		187.05.6					1.1		88.94.V	PM DEL PIEDE SENZA E CON MDC Incluso parti moli, distrato vascolare Incluso parti pieza del piez	107.154	28	-	+ +	-	08	Dagroatica per s	-
	ORBITE SENZA E CON MOC (MI SHL) + RM DEL NASSICCIO FACCIALE COMPLESSIVO								10.14 X	AND/O RM DELL MATO SUPERIORE	164 82 4	-	-	+ +	-+	10	Degranica per a	_
	RM DELLE ROCCHE PETROSE SENZA E CON MOC Incluse relative distribu vascolare fuin		+ +	_		-			88.94 Y	ANGIO RM DELL'ARTO INFERIORE SENZA E CON MDC	286.43 4	1				08	Diagrostica per i	_
	aministrie a RM DEL MISBICOLO FACCIALE SENDA E CON MDC (88 51 G), RM DELL'ARTICOLAZIONE TEMPOROMINADIBOLARE MONOLATERALE O BLATERALE SENDA E							68.94.2	ANGIO RM DELL'ARTO SUPERIORE SENZA E CON MDC	286.43 6	(08	Diagnostica per a		
· ·	CON MDC (IN \$1.46, RM DELLA SELLA TURCICA SENZA E CON MDC (IN \$1.7, RM DELLE CONSTRUCTOR E CON MDC ON \$1.11, RM OF ANY CONTROL OF ACCINE E CON MDC							Conference for 1	48.95.1	RM DELL'ADDOME SUPERIORE, Inclusio Fegato e vie bilan, mizza, pancreaa, ran e sumara, indimendiariant a testino, districto amoniara.	120.05 €	1				08	Diagrantica per à	
	SENZA E CON MOC (M PI M)	-	+			-			44.91.2	AM DELL'ADDOME SUPERIORE, SENZA E CON MDC: Incluse: Fegate e via bilari, mizza.	147 10 4				-	58	Distriction per à	
	RM DELLE ORBITE SENZA E CON MOC. Incluse relative distreto esecutare Nor esecutare a RM DEL MASSIGCIO FACCIALE SENZA E CON MOC. (MI ST GL RM DELL'HRTICOLAZIONE								an ed 3	pancraes, neri a surrari, refripertunes a relativo distratto vescolare	144 00 4	-	-	+ +	-	24	Dependence of a	
	TEMPOROMINDIROLANE MONOLATERNUE O BLATERNUE SENZA E CON MOC (REM H). RIN DELLA RELLA TURICICA NINZA E CON MOC (REM L). RIN DELLE ROCCHE PETRONE	107.05.4						Depresite per 4	88.95.4	RM DI ACDOME INFERIORE E SCAVO PELVICO Inches mistre datado vascilara	120.05 4	-	-	+ +	-	04	Diagrostica per t	
	SENZA E CON MDC (M FF K) RM DEL MASSICCIÓ FACCIALE COMPLESSIVO SENZA E CON									RM DI ADDOME INFERIORE E SCAVO PELVICO SENZA E CON MDC. Inclusi: Nativo distrito	147 10 4	-			-	14	Description per 1	
	THE DE MANDERSON FACTORIES COMPLETENCE SERVICE FOR MEX. Buds to defendence &		+ +			-			an ad a	VERIORY	144 61 4	-		+ +	-		Department	
	due o più segmenti. Incluso: relativo detretto vasculare. Non associabile a RM DEL MASSICOO								48.95.7	ANGIO FM DELL'ADDOME SUPERIORE SENZA E CON MDC	266.43 4	1	-	+ +	+	08	Diagnostica per a	
	TEMPOROMINENDELARE WORCLATERIALE O BLATERIALE SENZA E CON MDC (IM IT H).	107.05.4						Degradice per s	88.95.8	AM DI INGUINE, SCROTO E/O PENE, Incluso: relativo distrutto vascolare	120.05 4	1				08	Dagrontica per i	_
	RM DELLA SELLA TURICICA SENZA E CON MDC (IN 41 A) RM DELLE ROCCHE PETROSE SENZA E CON MDC (IN 51 K) RM DELLE ORBITE SENZA E CON MDC (IN 51 L)									AM DI INGUINE, SCRIDTO E/O PENE SENZA E CON MDC. Incluso: relativo distretto vancularia							A	_
N	AND/O RIM DEL DISTRETTO VASCOLARE INTRACRANICO SENZA E CON MDC	167.154						Depointia per i	48.95.9	INDI BERICEBINE & MAY DE ALLOUME, INFERIORE, E SCAVO PELVICO SENZA E CON MOC (18.95.5)	107.104	1					confidence back	
*	ANGIO RM DEL VIUE DEL COLLO SENZA E CON MOC	187.104		_		0		Degratita per 1	88.95.A	ANDIO RM DELL'ADDOME INFERIORE SENZA E CON MDC	286.43 6	(08	Diagnostica per i	_
1	HIS IN LISENSET HIS LICENSE, E QUANTITATIVE Inclusi: Exame III Inco. Rel STUD FUNITORIU ATTIVIZIONE CONTICALE Inclusi: Exame III Inco.	184.80 4	+ +	-		0	-	Deprestice per k	48.95.8	RM ENDOCAVITARIA	184.80 4	4			-	58	Degrantica per i	_
	RM D ENCEFALO E TRENCE ENCEFALCE. GUNDONE CRANE SPINULE E RELATIVO								88.95.C	INVENDOCAVITARIA SENZA E CON MOC	286.43 4	-	-	+ +	-	08	Dagvostica per i	
	prometro vancouvel benza e con contraatro incluse Anatosia e Valla anatosinistia per pagneti pedatro a nie coldenant	247.524						conficientia ba c	10.95.E	IN RECORD OF CONSTRUCT ON A CONSTRUCT OF CON	120.05	1	-	+ +	+		Diagronica per i	
	RM DE, TORACE (mediastro) europe paimen pante terencaj, incluso relativo detreto	115.80.4						Dagrantics per 1	88.95.7	INTELLE	184.80 4	1				08	Diagnostica per a	
	REVIDEL TORIACE SENIOR & CON MOC (mediatine, eurlage, polmon, parele tracina) instan	181,25.4						Degradita per i	48.97.2	RM DIFFUSIONE, incluso tansora di diffusione, incluso, Esame di base	184.80 4	(08	Diagnostica per è	-
	ANGIO: RM DEL DISTRETTO TORACICO	184.80.4	+ +	_	+			Degramita per 1	88.97.4	AM SPETTROSCOPA. Incluso Esene & bese	184.80 €	4			-	08	Diagnostica per a	_
	CINE HIM DEL CUCHE	120-05 €				-		Segueita per s	48.97.6	RM PERFUSIONE Incluse Example 6 base	184.804	-	-	+ +	-	08	Diagnostica per a	
-	CINE HM DEL CUORE NINGA E CON MOC CINE HM DEL CUORE, Salva a sun strais Anziensia	232.054	+ +	-				Depresina per s Depresina per s	10.97 8	RM DELLE VE DIGESTIVE CON MOC ORALE. Non associative a RM DELL ADDOME	200.414	+	-	+ +	+		conversion by a	
1	INV MAMMANA MONO E/O BLATERALE SENZA E CON MOC	187 104		_		0		Degrattia per s	88.97.9	SUPERIORE (M IS 1), RM DELLADOOME SUPERIORE, SENZA E CON MOC (M IS 2), RM DI	158.50 4						Deprint caper a	
	ANGIO RM CRUDON BELOW TO TORACICO SENZA E CON MDC	107 104	+ +	_	1	0		Deposition per ti		ADDOME INFERIORE E SCAVO PELVICO (M 95.4), RM DI ADDOME INFERIORE E SCAVO PELVICO SENZA E CON MDC (M 95.5)								
	THE OR AND CONTRACT AND ADDRESS A MADE IN COLUMN AS A VIEW AND A VIEW AND AND A VIEW AND AND A VIEW AND A	112,014	11	_	+	-		Department of a	M 97.A	COLANGIO FM	120.05	1				38	Diagnostica per a	-
_		10.404	1.1	_	+	-			88.97.8	COLANGIO FM. Con etimolo fermacologico	140.104	(98	Diagnostica per i	
-	THE DRUK MACHINE CONTRACT NOR ANALYSING A PROCEDURE A TRACKING AN TOTO (M. 83.4)	111.634		_				comprisition per s		RM DELLE VIE DIGESTIVE CON MOC ORALE SENZA E CON MOC VENDSO. Non associable a								
4	AN 11.0	115.80.4	Н.	_				Degrantia per i	68.97 C	IND DELL'ADDOME SUPERIORE (M 95 1), RM DELL'ADDOME SUPERIORE, SENZA E CON MOCURENT 1, RM DEADDOME NEERIORE E SCALD REVICES (R 95 4), RM DEADDOME	158.50 4						Diagrostica per à	
	HIS US, NAUHUR SAUADCOCCUED for associative a NM CELLA COLUMNA IN 1010	in all a	1 I					Description of a		A REAL PROPERTY AND A REAL		1		1 I.	- I			

Fig.1 Sicilian Region outpatient specialty nomenclator 2024

MR examination: execution times analysis

The table summarizes the execution times of a MRI examination with 1.5T and 3T scanners, respectively, based on different sources of scientific literature without and with the integration of Artificial Intelligence.

Tab.2 Average acquisition times by body district. Indicative among major vendors, without and with AI

MR EXAMINATION	TEMPORAL RESOLUTION SCANNER MRI 1.5Tw/oIA	T E M P O R A L RESOLUTION SCANNER MRI 1.5T With IA	T E M P O R A L RESOLUTION SCANNER MRI 3.0 T w/o IA	T E M P O R A L RESOLUTION SCANNER MRI 3.0 T with IA		
MR of the Brain,and Related Vascular District	20-25min	10-15min	18-20min	8-10min		
MR of the Brain,and Related Vascular District with and w/o Contrast	25-30min	12-18min	21-23min	10-12min		
MR of the Brain and An- gio-MRI of the Intracranial Vascular District	25-30min	12-18min	21-23min	10-12min		
MRI of the Neck with and w/o Contrast	30-35min	20-25min	25-30min	18-20 <i>min</i>		
MRI Maxillo Facial	30min	20min	25min	15min		
MRI of the Sella Turcica	40-45min	30-35min	30-35min	20-25min		
MRI of the Petrous Bones	25-30min	12-18min	18-20min	10-12min		
MR Orbits With Contrast	30-35min	25-30min	20-25min	18-22 <i>min</i>		
Cardiac MRI Contrast	50min	20min	40 min	20min		
Breast MRI with Contrast	25-35min	16-24min	18-20min	15min		

JOURNAL OF ADVANCED HEALTH CARE TSRM PSTRP



RESEARCH ARTICLE

Citation:

C. Curatolo et al. "Application of Artificial Intelligence in Magnetic Resonance Imaging: Implementation of a Healt Technology Assessment (HTA)"

JAHC 2024 Vol 6 - 3

Received: 2024-09-13 Revised: 2024-09-16 Accepted: 2024-10-20 Published: 2024-10-21



Copyright: © 2024 by the authors. Submitted fo possible open access publication under the terms and conditions of the Creative Attribution Commons (CC BY) license (https:// creativecommons.org licenses/by/4.0/).

3

4

MR Cervical Spine	20-22min	10-12min	16-18min	10-12min		
MR Cervical Spine with Contrast	22-24min	11-13min	18-20min	12-14min		
MR Dorsal Spine	20-22min	10-12min	16-18min	10-12min		
MR Dorsal Spine with Con- trast	22-24min	11-13min	18-20min	12-14min		
MR Lumbar Spine	22-24min	12-14min	18-20min	12-14min		
MR Lumbar Spine with Contrast	24-26min	12-14min	20-22min	14-16min		
MR Total Spine	60-70min	40-50min	60-70min	35-45min		
MR Total Spine with Con- trast	68-78min	44-54min	65-75min	40-50min		
ARTRO-MRI	20-30min	15min	20-30min	15min		
MR Shoulder / Contrast	20-30min	15min	20-30min	15min		
MR Elbow / Contrast	30-35min	15-20min	20-25min	10min		
MR Hand/Wrist Contrast	30-35min	15-20min	20-25min	10min		
MR Sacro-iliac joint with Contrast	30-40 <i>min</i>	15-20min	20-30min	10-15min		
MR Sacro-iliac joint	30-40 <i>min</i>	15-20min	20-30min	10-15min		
MR Femoral Contrast	30-35min	15-20min	20-25min	10min		
MR Knee with Contrast	20-25min	10-12min	15-20min	5-8min		
MR Ankle/Feet Contrast	30-35min	15-20min	20-25min	10-15min		
MR Upper Abdomen	20-30min	10-20 <i>min</i>	20-30min	10-20min		
MR Upper Abdomen with Contrast	30-40 <i>min</i>	15-20min	20-30min	10-15min		
MR Abdomen Pelvis	25-35min	10-15min	15-25min	10-15min		
MR Abdomen Pelvis with Contrast	35-45min	15-25min	25-35min	15-25min		
MR cholangiography	20-30min	10-20min	20-30min	10-20min		





Data Analysis and projections

The efficient and productive management of an MRI department is a crucial challenge to ensure high quality care and resource optimization. In this context, we analyzed a hypothetical scenario in which the MRI department is equipped with two scanners one 1.5 Tesla and one 3 Tesla with a highly structured weekly examination schedule management. Hypothetically, we estimated a number of MRI examinations that can be performed during a 12-hour

daily shift, considering the different types of examinations expected in an MRI department, in detail, Monday through Saturday: Monday neuro, Tuesday muscle, Wednesday abdomen, Thursday heart, Friday neuro and facial massif, Saturday neck. In addition, we took into account the time needed to position and prepare the patient between examinations (10-15min). Cost analysis took in conconsideration the cost-benefit ratio.

RESULTS

Evaluation of Contrast Resolution (CNR) and Spatial Resolution(SNR) One of the main benefits of using AI in MRI is the improvement of contrast resolution. With AI, in particular with Deep Learning systems, background noise in images can be effectively reduced, thereby improving the signal-to-noise ratio. This allows images with greater contrast and detail to be obtained, facilitating diagnosis and interpretation by radiologists [11,12]. In addition, AI enables the best use of the temporal resolution of MRI, allowing increased spatial resolution without compromising acquisition time or contrast resolution. Usually, as spatial resolution increases, noise increases proportionally, making image interpretation more difficult. Thanks to the intervention of AI, this problem is overcome, making it possible to obtain high spatial resolution MRI images with excellent contrast resolution free of any kind of artifacts and in low acquisition time [13]. This innovative approach based on the integration of AI in MRI represents an important step in the evolution of diagnostic imaging, offering radiologists more powerful and accurate tools for the analysis and interpretation of MRI images, with positive effects on the quality of diagnosis and patient care [14].

Temporal Resolution

Temporal Resolution, or the ability to acquire images in reduced times, is a key aspect in magnetic resonance imaging (MRI). MRI scanners at 1.5T typically require longer acquisition times than 3T systems because of the lower magnetic field strength. However, the application of artificial intelligence solutions results in a more pronounced reduction in acquisition time in 1.5T scanners than in 3T scanners [15]. This is because AI can more effectively compensate for the limitations associated with the lower magnetic field strength in 1.5T scanners by optimizing image acquisition and reconstruction processes. As a result, the integration of AI in 1.5T scanners achieves higher temporal resolution than 3T systems without such advanced technologies, approaching or even exceeding the temporal performance of conventional 3T scanners. This significant reduction in examination time not only decreases motion artifacts. But it also improves patient compliance and experience, particularly for patients with claustrophobia, dramatically reducing the discomfort and anxiety associated with longer examinations and allowing more people to perform the examination.

MR Studies providable

According to our projections:

 with the 1.5 TMR scanner, with the AI application 113 MR exams would be weekly performed (vs 85 ones without AI),with an increase of 32.94% in MR exams performed with the 3MR scanner, with the AI application 137 MR exams would be weekly performed (vs 106 ones without AI), with an increase of about 30% in MR exams performed

Cost Analysis

The implementation of AI in the MRI Imaging process would allow a significant increase in departmental productivity. Based on the data collected, in a year with 312 woking days (excluding Sundays and holidays), the use of AI would allows approximately 1456 and 1612 more MRI examinations to be performed for the 1.5T and 3T scanners, respectively, in comparison with the system without AI, with an increase of 32.94% and 29.25%, respectively. This would correspond to an increase in weekly productivity of 28 (1.5T) and 31 (3.0T) MRI examinations. This would lead, considering the minimum and maximum remunerations according to the actual regional fee schedule, corresponding to 115.8 euros (for spine MRI) and 247.5 euros (for encephalic MRI without and with ev contrast medium), respectively to an increase in annual revenue of approximately 168,604-360,360 euros (average 264,482) with 1.5T scanners and 186,669-398,970 euros (average 292,819) with 3T scanners. Thus, according to the cost-benefit formula, which allows objective quantification of the cost-effectiveness of the technological investment, facilitating adoption decisions by healthcare decision makers.

COST-BENEFIT = BENEFIT-TOTAL/COST-TOTAL

Where:

- Total benefits: represent the total economic value of benefits gained from technology adoption, such as avoided health care costs, additional revenue, etc.

- Total costs: represent the total investment required to adopt the technology, including costs of purchase, implementation, maintenance, etc. We get:

- Cost-benefit ratio (1.5T) = (168,604 € - 360,360 € in additional revenue) / (150,000 € - 280,000 € initial investment)

=

Cost-benefit ratio (3T) = $(186,660 \in -398,970 \in$ in additional revenue) / (200,000 € - 320,000 € in initial investment)

= 292.819 € / 260.000 € = 1.12

In addition, considering an estimated initial investment for the adoption of the software with AI of between 150,000-280,000 euros in 1.5T and 200,000-320,000 euros in 3T, this would then be amortized in 1 year of work, following which no additional expenses are expected over and above the

5



Citation: C. Curatolo et al. "Application of Artificial Intelligence in Magnetic Resonance Imaging: Implementation of a Healt Technology Assessment

JAHC 2024 Vol 6 - 3

(HTA)

Received: 2024-09-13 Revised: 2024-09-16 Accepted: 2024-10-20 Published: 2024-10-21



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/ licenses/by/4.0/). 6

initial investment, with an imposing and progressive increase in revenues in the years following the year of investment, thus proving to be largely recoverable in the short to medium term.

DISCUSSION AND CONCLUSIONS

The results of our HTA model demonstrate that the application of AI in MRI results in an efficient and effective maneuver on various fronts:

- positive and gradually increasing cost-benefit ratio, particularly after 1 year after the investment, with an increase in the department's productivity;
- the increase in the number of MRI examinations provided by the department contributes to the current goal of the OUs and Hospital Az. Directorates of reducing waiting lists

• Improved image quality and consequent better support for diagnosis

JAHC (ISSN 2704-7970)

Increased the pool of patients served: faster examinations are better tolerated by low-compliant patients.

Artificial intelligence represents a revolutionary technology, the application of which in MRI sees many worthy implications of the Health Technology Assessment process and which directly involves health care providers, hospital companies, and the regional and national health care system [16]. Our hypothetical model showed numerous advantages and in particular the possibility of increasing the number of MRI examinations that can be delivered by the hospital company, with the potential to contribute to the achievement of the recent Italian National Plan 2024-2026 goal of reducing waiting lists for diagnostic examinations.

REFERENCES

- Anselmi L. (2008), Il contributo economico aziendale alla valutazione delle tecnologie sanitarie, Relazione plenaria al Workshop Governare l'innovazione tecnologica in sanità. L'Healthcare Technologies Assessment, Pisa, 7 marzo 2008.
- 2. Cicchetti A, Marchetti M "Manuale di Health Technology Assessment" Il pensiero scientifico 2010.
- 3. Citraro L., Di Vagno R., Giuliani G., Iannella M.L., Marino R., Terranova F., "Health Technology Assessment: un Ponte tra scienza e policy making" (2013).
- 4. Corio M., Paone S., Ferrone E, Meier H., Jefferson T.O. e Cerbo. Revisione sistematica degli strumenti metodologici impiegati nell'Health Technology Assessment, Agenas, Roma (2011)
- 5. Del bene L. "Il supporto del controllo di gestione nelle aziende sanitarie", Giuffrè (2000)
- 6. Italiano G. F., "Intelligenza artificiale: passato, presente, futuro" in Pizzetti F. Intelligenza artificiale, protezione dei dati personali e regolazione, Giappichelli, 2018, 206 ss
- 7. O'Sullivan, S., Fleur Jeanquartier, F., Jean-Quartier, C., Holzinger, A., Shiebler, D., Moon, P., & amp; Angione, C.; Developments in AI and Machine Learning for Neuroimaging;
- 8. Lettieri E. e Masella C. "Un modello a supporto della valutazione e selezione delle tecnologie mediche innovative nelle organizzazioni sanitarie", Mecosan, (2006)
- Currie, G., Hawk, K. E., Rohren, E., Vial A., Klein, R.; Machine learning and deep learning in medical imaging: Intelligent Imaging. Journal of Medical Imaging and Radiation Sciences, 50(4), 477–487. 2019 doi. org/10.1016/j.jmir.2019.09.005;
- 10. Lundervold, A. S., Lundervold, A., An overview of deep learning in medical imaging focusing on MRI. Zeitschrift Für Medizinische Physik, 2019; vol.2, 102–127. doi.org/10.1016/j.zemedi.2018.11.002;
- Curatolo C. Studio comparativo tra la tecnica Compressed SENSE e SENSE per l'imaging RM della Mammella. XXVIII numero Rivista TSRM FOR EVERYONE 2021- Tecnico-Scientifica Riconosciuta e Patrocinata Dalla Federazione Nazionale Collegi Professionali Tecnici Sanitari di Radiologia Medica Prot. N 496/2012 Nazionale
- 12. Curatolo C, Amato MC, Daricello M, Caruso V, Lo Re G, Galia M, Lo Casto A. Application of the compressed SENSE in the study of female pelvi in magnetic resonance 3 Tesla for the diagnosis of infertility in women. Journal Of Advanced Health Care, Volume 4, 22 Luglio 2022. DOI https://doi.org/10.36017/jahc2207-04.
- 13. Curatolo C, Santoro V. Nuovi scenari sulle tecniche PMRI: il Compressed SENSE. Journal Of Advanced Health Care 2019 (ISSN 2612-1344)2020-Volume 1- ISSUE I
- 14. Fleysher, R., Jaspan, O. N., Lipton, M. L. (2015) Compressed sensing MRI: A review of the clinical literature. The British Journal of Radiology, 88(1056), 20150487. Estratto da: https://doi.org/10.1259/bjr.20150487;
- Tang, H., Hu, N., Yuan, Y., Xia, C., Liu, X., Zuo, P., Stalder, A. F., Schmidt, M., Zhou, X., Song, B., & amp; Sun, J. (2019). Accelerated time-of-flight magnetic resonance angiography with sparse undersampling and iterative reconstruction for the evaluation of intracranial arteries. Korean Journal of Radiology, 20(2), 265. https://doi. org/10.3348/kjr.2017.0634;
- 16. Deng L. and Yu D. Deep Learning: Methods and Applications. Foundations and TrendsR in Signal Processing, vol. 7, nos. 3–4, pp. 197–387, 2013. DOI: 10.1561/2000000039



