

Magnetic resonance imaging (MRI) utilization in a Ghanaian teaching hospital: trend and policy implications

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SUMMARY

Background: The use of Magnetic Resonance Imaging (MRI) is new in Ghana compared with some Western countries. A number of studies have observed increased MRI utilization due to increased sensitivity to diagnosis, and the paradigm shift to modalities that do not use radiation. Challenges with MRI use include high cost of the examination and inappropriate requests by referring clinicians.

Objective: To determine the MRI utilisation trend in Korle Bu Teaching Hospital (KBTH), Ghana and its policy implications.

Materials and Methods: A retrospective study undertaken in the Radiology Department, KBTH, from February to March, 2017. Eight hundred and forty request forms for MRI studies between January, 2013 and December 2016 were reviewed. Information on patient's age and sex, number of MRI studies done, body parts and clinical conditions evaluated, appropriateness of clinical requests and existing policies on MRI in Ghana was gathered. Measures of central tendency and spread were obtained. Chi square, Pearson's correlation and linear regression analysis were also used in the analysis.

Results: The top three body parts requested were Spine (55 %), Brain (19%) and Joints (6 %); degenerative disease was the most common clinical condition evaluated.

Significant association and correlation were obtained between of the number of body parts evaluated and examination year as well as the variety of clinical conditions requested and examination year.

Conclusion: A progressive increase was noted in MRI utilisation both in number and diversity but no policy guiding MRI use in Ghana exists.

Keywords: Trend, magnetic resonance imaging, Ghana, policy

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INTRODUCTION

The use of Magnetic Resonance Imaging (MRI) is relatively new in Ghana compared with some parts of the Western world and Asia. The first diagnostic MRI machine in Ghana was installed at the Radiology Department of the Korle Bu Teaching Hospital (KBTH) in 2006 and by 2010, others were installed in two other teaching hospitals in the country. Subsequently, several MRI machines have been installed in Ghana, mainly in the private sector which resulted in increased MRI utilization. Studies done in North America and Asia have observed increased utilization of Computed Tomography (CT scan) and Magnetic Resonance Imaging (MRI) and have postulated reasons for this increased utilization.

The main reason is increased sensitivity to diagnosis, as several conditions which hitherto could not be diagnosed, are now very easy to diagnose. Other reasons include increase in patient self-request and doctors' fear of legal suits for missing a diagnosis, especially in the Western world.^{1,2} Additionally, the paradigm shift from imaging modalities using high radiation doses to those using minimal or no radiation has also promoted the use of MRI.³ The increased use of MRI in health care delivery has brought to the fore some major challenges one of which is an increase in the cost of healthcare which includes the cost of purchase and the need to employ skilled personnel like radiographers and radiologists to use the equipment.^{4,5}

In Ghana, most people pay for this service out of pocket, forcing some clinicians to do a cost-benefit analysis before requesting MRI for their patients. However, its diagnostic ability and other benefits far outweigh the challenge of increasing medical expenditure.⁶ A major challenge in the utilisation of MRI in many countries is the inappropriateness of the MRI requests received from referring clinicians. Other concerns include the choice of MRI rather than cheaper modalities with good sensitivity and radiologists suggesting MRI when they could have obtained answers by reviewing previous imaging studies of patients.^{2,3,7} The results of studies on MRI utilisation trend have led to the implementation of policies and strategies to address the abuse associated with its use various institutions.^{2, 7,8,9} In 2012, the Government of Ghana (GoG) decided to provide teaching and regional hospitals with at least one CT scan and one MRI machine.¹⁰ However, to date, no review has been done to assess MRI use in the management of patients in Ghana. It is unclear whether doctors are requesting the examination for the right reasons and if there is a policy regulating the use of MRI in KBTH or Ghana.

The aim of this study is to determine the MRI utilisation trend in KBTH, Ghana and how it would influence policy on MRI utilisation in the hospital and Ghana. The objectives of the study were to:

1. To examine the trend of MRI utilization in KBTH from 2013 to 2016
2. To find out if there is an MRI policy in KBTH/MOH
3. To identify any policy implications of the observed trend of MRI utilization in KBTH

METHODS

This was a quantitative retrospective study carried out in the MRI Unit of the Department of Radiology, KBTH, Accra, Ghana from 1st February, 2017 to 31st March, 2017. KBTH is a Tertiary Healthcare Institution. The hospital is the main referral point for the southern sector of Ghana as well as for some countries in the West African sub region. It has a Toshiba Vantage 1.5T MRI machine which is one of the best in the sub region. KBTH sees a wide variety of cases from about 17 specialized and subspecialized areas which make the choice the facility appropriate for such a study. All the available request forms for MRI studies that took place from 1st January, 2013 to 31st December 2016 were reviewed. Information on age and sex of the patient, the number of MRI studies done in each calendar year, different body parts that were evaluated, different clinical conditions evaluated, appropriateness of requests for MRI study and existing policies on MRI in KBTH or Ministry of Health (MOH) was gathered. No questionnaires were used since study did not involve patients.

To determine appropriateness of the request, the America College of Radiologists document on appropriateness criteria was used as a guide for the clinical conditions¹¹ using the details of the clinical information on the request form as an index of appropriateness. The request forms were grouped into two; those with adequate detail for a particular clinical condition hence appropriate and those with inadequate detail or wrong indication, thus inappropriate. Information obtained from the data collection was documented as an MS Excel document. After the initial entries, the data was checked to ensure that every entry had been correctly done. The corrected data was coded appropriately and fed into SPSS version 20 software for the various forms of analysis to be done. Descriptive statistics like measures of central tendency and spread were obtained. Statistical tests like chi square and Pearson's correlation were performed to find out any significant association and correlations between the parameters like the number of inappropriate requests, age of patients, body parts and disease groups. Linear regression analysis was used to find out if time was a strong predictor of number and diversity of cases on the clinical requests.

Sample size determination

Using a sample size formula by Kish Leslie (Kish, 1965)¹², the sample size per year was estimated as 201 request forms making a total number of 840 for the study period. The total MRI studies done in the Radiology Department between 1st January 2013 and 31st December 2016 were 680, 1619, 983 and 1744 for 2013, 2014, 2015 and 2016 respectively. To achieve a sample of 210 per annum, the retrieved and acceptable request forms were numbered serially for each year and with the help of Microsoft Excel 2015, random numbers were generated and this was used to select a sample of 210 for each year and a total of 840 request forms for the study. The patient attendance records in the Radiology Department showed that the MRI machine did not work for 5 months in 2013 and 4 months in 2015.^{13, 14} Using monthly averages and correcting for the downtimes, the expected numbers were computed to be 1360, 1619, 1474 and 1744 for 2013, 2014, 2015 and 2016 respectively.

Ethical approval was obtained from the Institutional Review Board (IRB) of KBTH (IRB/00097/2016).

RESULTS

A total of 840 request forms were analysed for the four-year period, out of which 415 (49.4%) were for females and 425 (50.6%) for males, giving a ratio of approximately 1:1. The mean ages were; females 47.1 years (SD 19.6), males 45.7 years (SD 20.2) and total population 46.4 (SD- 19.9). The age of patients evaluated increased from the third decade to the six decade and then reduced gradually after that.

The age-group with the highest number of requests was 50-59 year group with 165(19.6%), followed by 40-49 year group, 143 (17.0%) and then 60-69 year group, 141 (16.8%). The group with the least was 90-99 year group 1(0.1%). The body parts evaluated in the four years period were summarised into Abdomen and Pelvis, Joints, Spine, Brain, Other extremity parts (other parts of the extremities except the major joints), Head and Neck, and others (parts with low frequencies).The top four body parts requested for MRI over the 4 years were Spine (55 % to 70%), Brain (19% to 30%), Joints (6 % to 10%) and Abdomen and Pelvis (3% to 5%) as seen in Table 2. A Pearson’s correlation analysis found a significant correlation between the number of the different types of body parts evaluated and the year of evaluation over the four-year period ($r = 0$).

The clinical conditions stated on the request forms were also grouped into disease groups. These were congenital, connective tissue/autoimmune, inflammatory/infections, metabolic/endocrine, neoplasia-benign, neoplasia-malignant, degenerative, neurodegenerative, nonspecific (those difficult to tell what the exact condition being evaluated was) and others (those consisting of two or more of the major groups being evaluated). The four most evaluated disease groups were degenerative disease group with proportions between 42.9% and 58.6 %, followed by trauma, between 6.7% and 12.9% as shown in Table 2.

A Pearson’s correlation analysis found no correlation between the number of the different types of disease groups evaluated and the year of evaluation ($r = 0.87$).

The study showed that between 20% and 32.4% of the request forms evaluated in the study did not have adequate or the right information to justify the MRI study requested, thus inappropriate. The appropriateness/inappropriateness of the requests was also evaluated for the major disease conditions. The study showed that degenerative disease has the highest proportion of inappropriate request of 55.1%, followed by Benign neoplasm, 33.3%, Inflammation/Infection 12.5%, Vascular 7.7%, Trauma 7.1% and Malignant neoplasm 5%. Metabolic conditions and neurodegenerative conditions scored 0% inappropriate request.

A chi-square analysis conducted did not show any significant association between the appropriateness of the request and the disease groups evaluated, age of the patients and body parts ($p>0.05$) shown in Table 3. An assessment was also made to find out if there was any correlation between the variety of the clinical conditions requested for the different disease groups and the body parts evaluated on one hand and the year of examination on the other hand. The exercise yielded a weak positive relationship between the varieties of clinical conditions for the body parts and the year the evaluation was done; the R^2 value was 0.3. There was a strong positive correlation of R^2 of 0.544 ($R=0.79$) between varieties of clinical conditions written on the request forms for the different types of the disease groups and the year of evaluation. This is shown in Figure 1.

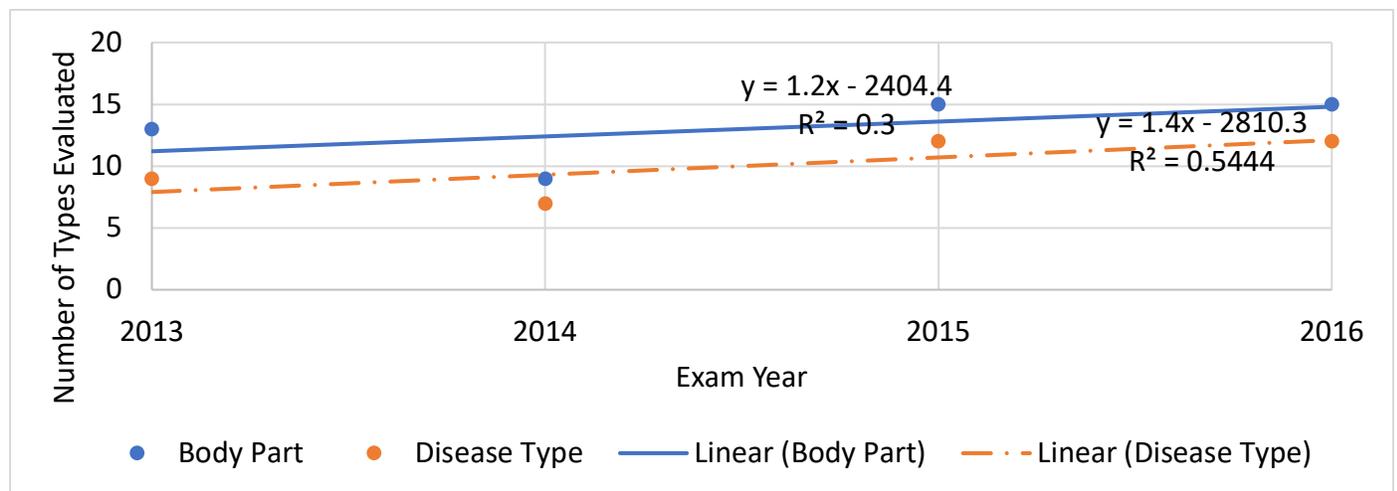


Figure 1 Relationship between the varieties of the clinical conditions on the request forms of the different body parts and disease groups and the examination year

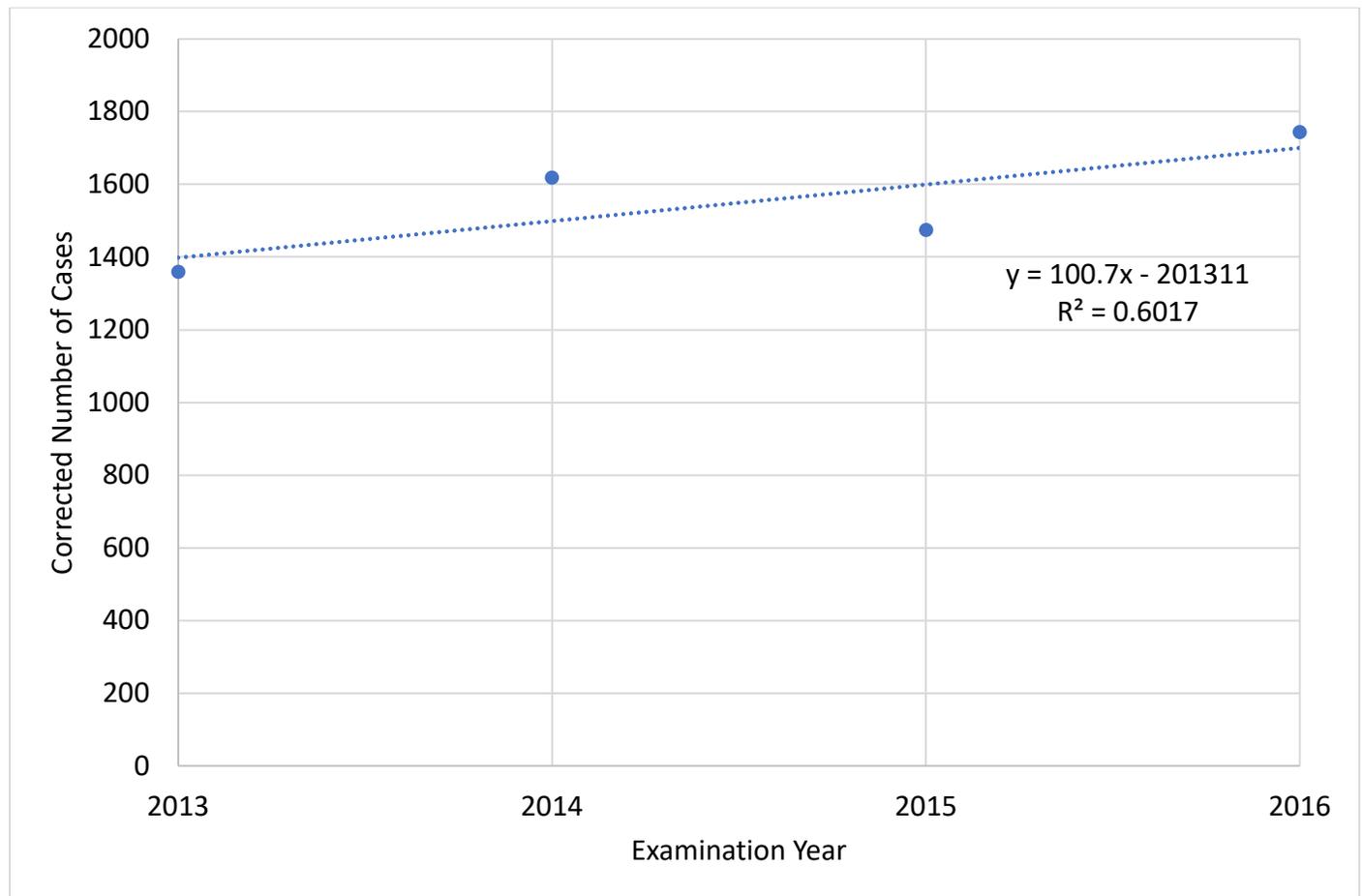


Figure 2 Relationship between corrected number of cases evaluated done in a year and the examination year

A regression analysis was done between the recorded and estimated (for those with less than a year’s record) number of request forms and the examination year showed a positive correlation with an R² of 0.60, see Figure 2.

Finally, we searched through files at the offices of the administrator and head of department and could not find any correspondence on a policy on MRI utilization in Korle Bu or Ghana.

Table 1 Body parts evaluated per year

Exam Year	2013	2014	2015	2016
Disease Type	n(%)	n(%)	n(%)	n(%)
Spine	115(54.8)	126 (60)	147(70)	125 (59.5)
Brain	63(30)	51(24.3)	40(19.0)	55 (26.2)
Joints	20(9.7)	13(5.2)	12 (4.8)	16 (7.2)
Abdomen & Pelvis	7(3.3)	10(4.7)	6(2.9)	8(3.8)
Extremities	2(1)	10(4.8)	2(1)	5(2.5)
Head & Neck	1(0.5)	0	2(1)	0
Others	2(1)	0	1(0.5)	2(1)
Total	210(100)	210(100)	210(100)	210(100)

Table 2 Major disease groups evaluated per year

Exam Year	2013	2014	2015	2016
Disease Type	n (%)	n(%)	n (%)	n(%)
Congenital	2 (1.0)	14(6.7)	1(0.5)	2 (1.0)
Connective Tissues/ Autoimmune	0	0	1(0.5)	1(0.5)
Degenerative	90(42.9%)	98(46.7)	123(58.6)	102(48.6)
Inflammatory/ Infection	10(4.8)	0	5 (2.4)	7(3.3)
Metabolic/ Endocrine	1(0.5)	0	0	1(0.5)
Neoplasia-Benign	2(1.0)	0	2(1)	4(1.9)
Neoplasia-Malignant	11(5.2)	17(8.1)	13(6.2)	19(9.0)
Neurodegenerative	0	0	0	1(0.5)
Nonspecific	18(8.6)	24(11.4)	17(8.1)	23(11.0)
Others	32(15.2)	27(12.9)	19(9.0)	23(11.0)
Trauma	27(12.9)	20(9.5%)	18(8.6)	14(6.7)
Vascular	17(8.1)	10(4.8%)	11(5.2)	13(6.2)
Total	210(100)	210(100)	210(100)	210 (100)

Table 3 Test of association for various parameters evaluated

Association Testing	Test Statistic	Value	df	P-value
Appropriateness of Request Vs Body part	Pearson Chi-Square	335.015a	320	0.271
Appropriateness of Request versus Patient Age	Pearson Chi-Square	309.747a	288	0.181
Appropriateness of Request versus Disease Group	Pearson Chi-Square	304.000a	279	0.145

DISCUSSION

Among the 840 request forms evaluated for all the four years, 415 (49.4%) were for females, while 425 (50.6%) were for males, giving a ratio of approximately 1:1. The mean ages were; females 47.13 years (SD 19.6), males 45.68 years (SD 20.2) and total population 46.39 (SD-19.9). It is worth noting that the mean age of the study population was close to that obtained by Becker et al in South Africa, who documented a mean age of 47.6 years.⁴ The similarity in the mean may be due to the fact that both study sites where the studies took place were public health facilities which see patients of all ages and clinical conditions.

The commonest body part evaluated was the spine comprising 54.8% to 70.0% of the studies done followed by brain between 19% to 30%. Becker et al documented a similar trend with the top two parts evaluated being spine and brain.⁴ Quaday et al, obtained a different trend in their study in an academic Emergency Department where they noted that more patients had evaluation of their brain than their spine, even though both body parts remained the top two parts evaluated. Being in an emergency department setting, could explain why they documented more patients with brain MRI than spine as noted in this study and that by Becker et al both of which were conducted at centres which see patients with more diverse clinical conditions.^{4,15}

The clinical conditions evaluated in this study were grouped into various disease groups with the top two groups evaluated being degenerative disease making up between 42.9%- 58.6% of the MRI scans done and trauma between 6.7%- 12.9%. It is not surprising that degenerative disease was the most requested clinical condition because the spine was the most evaluated body part and most MRI scans of the spine are requested for patients with degenerative disease symptoms. Studies by Shinagare et al, Raja et al and Freeman et al showed that more patients were evaluated for central nervous system (brain and spine) related conditions and trauma in their institutions than was found in this study.^{3,7,16}

The difference is due to the fact that their studies focused on patients in the emergency and in-patient departments which are different from the setting of a general radiology department which sees out-patients, in-patients and patients from the emergency department.

This study showed a statistically significant correlation between the number of the different types of body parts evaluated and the examination year but not so for the disease groups. This seems to suggest that as the years progressed, the number of MRI studies requested by clinicians for the different body parts increased. However, any perceived or observed relationship between number of disease groups and examination year is purely due to chance. It is expected that as more clinicians become familiar with MRI the clinical indications for the study will increase in both number and diversity.

This study also assessed the variety of clinical conditions on the request forms for each of the four years with respect to the disease groups and body parts and showed a weak positive relationship between body parts and the year of evaluation but a strong positive correlation between disease groups and year of evaluation. This could be due to the fact as the years progressed more information on the use of the technology became available to clinicians thus increased its utilisation both in numbers and diversity. The same reason may be given for the strong positive correlation between the number of patients evaluated in a year and that examination year which meant that the requests for MRI increased as the years went by. Similar trends were observed by Quaday et al, Raja et al, and Redd et al.^{2, 7}

Doshi et al, found in their study that MRI is only second to plain radiography when they ranked inappropriate radiology studies in their research.⁹ This study found out that 20%-32.4% of the examinations requested were not appropriate. This finding compared favourably with what Becker et al noticed in their study in the Western Cape, South Africa, where one-third of the request forms were inappropriate.⁴ This study also looked at inappropriate requests with respect to the disease groups and the body parts of patients being evaluated and did not find any significant association or correlation between these variables. This means that any perceived relationship is purely due to chance.

Degenerative disease was the disease group with the highest proportion of inappropriate requests with as high as 55.1% of the requests being inappropriate. A study by Freeman et al in the United Kingdom on inappropriate MRI scans showed that 50% of the requests were inappropriate which seems to support what this study found for degenerative disease conditions.¹⁶

The issue of inappropriate MRI request is a major one and it is well documented that the effect of unnecessary MRI requests is a strain on the finances of individuals, healthcare institutions, insurance companies and the nation at large. This has been confirmed in our study where as high as a third of all the MRI requested being inappropriate. It is therefore not surprising that many health authorities tend to target radiological investigations anytime they want to reduce the cost of healthcare.^{2,3,7}

Health personnel have been mentioned as major contributors to inappropriate requests, however because this study was a retrospective one, we could not confirm or deny this assertion. A study by Doshi et al showed that an average of 4% of all inappropriate MRI requests were on the recommendation by a radiologist and added that reviewing patients' prior studies may help eliminate this problem.⁹ Chou Chen et al also mentioned that physicians are more likely to request MRI for physicians than ordinary patients.¹⁷ Becker et al, also tried to look at the grade of the requesting physician with respect to the appropriateness of the request and found out that contrary to most people's expectation, consultants had the most inappropriate requests followed by medical officers, with interns and registrars with no inappropriate requests⁴. They further explained that interns were more likely to consult their seniors before requesting or may only be allowed to take decisions on straightforward scans. All these aforementioned important factors though not directly evaluated in our study may have culminated in us seeing as high as 55% of the requests for the most evaluated clinical condition being inappropriate.

The issue of vetting MRI requests by radiologists before they are done has also been associated with reduction in inappropriate MRI scans.^{2,3,4,9} Most of the institutions vet request forms using the ACR appropriateness criteria document and it is believed to be a very powerful tool for streamlining MRI requests.^{3,4,7,14} Though novel, two factors may make such a practice difficult in a centre in Ghana. There are very few MRI centres in the country so some patients have to travel far to access some of these facilities. It is often not prudent to send patient back to their referring clinician to correct any anomalies on the form before the study is done, as it may lead to undue delays in having the study done. Secondly the cost of running MRI services in the country is very high, thus the cost of the study is higher than what the average individual could afford. It may not make economic sense to most providers to send patients back to their doctors only to have them do it at another centre which will be ready to have it done for them irrespective of nature of the request.

The use of electronic request like emails (internal and external) and WhatsApp may offer radiologists the opportunity to vet these requests before patient physically arrives at the centre, thus worth exploring.

It is clear from the ongoing discussion that having a high proportion of inappropriate requests as was noted in this study should be a source of worry. This coupled with the fact that no policy document on MRI use in the institution points to the fact that urgent steps are needed to curb this anomaly before it gets out of control. KBTH and for that matter the MOH of Ghana can leverage on some of the steps taken in the above examples to formulate a policy for MRI use in the institution or even the country at large.

It is therefore recommended that the KBTH and MOH should champion the formulation of a policy to guide the clinical use of MRI both in KBTH and in Ghana as a whole. This will help clinicians obtain the most benefit from the technology and reduce its abuse to the barest minimum. The policy could be formulated by a group of experts in Ghana using that of the American or European Colleges of Radiology to guide them.

The study had some limitations that are worth noting. Some of the request forms were poorly filled and thus could not be used. Being a retrospective study, it was sometimes difficult to establish whether the indication stated on the request form was an established diagnosis or just a suspicion. For some of the forms, it was possible to contact the patient or referring physician for clarification. Those that could not be verified were not included in the study

CONCLUSION

This study showed a progressive increase in MRI utilisation in KBTH both in number and diversity between January 2013 and December 2016 with close to a third of the requests being inappropriate. It also found that there is no policy guiding the use of MRI in Ghana.

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