Implementation of a CDSS for radiology in the EHR

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1. Introduction

The utilization of radiological investigations has increased the last several decades.[1–3] This evolution can be explained in part by the ageing population, the growing number of radiologists and an expanding list of indications.[2,3] The surge in technological advances in the field also provided an increase in choice, safety, and availability of certain investigations. Studies also found potential factors that influence the behaviour of the referring physician: including the patient's expectations, an increase in assertiveness, knowledge, and trust in technology by patients, the uncertainty of the physician, defensive medicine, fear of legal prosecution and economic motives. [1,3–5]

This increase in radiological investigations has resulted in longer waiting lists, an increase in radioactive exposure for the population despite lower radiation exposure per investigation and a higher cost for health care budgets. In Belgium, the cost of medical imaging alone accounted for 1,3 billion euros of the annual budget of 2017, which is particularly high if compared internationally.[6] Another problem these factors may contribute to is wasteful investigations: repeat investigations, investigations with insufficient clinical information or unclear questions, investigations where the results have no effect on therapy, too often or wrong investigations, and over-investigation.[1,3,7]

Attempts have been made to reduce this overconsumption, including information campaigns, audits, feedback and financial incentives. A Belgian information campaign reached 65,5% of the GPs but only influenced their ordering in 30,8% of the cases.[1] Unfortunately, after analysis, these and other interventions had only minor positive effects if any at all. [1,8] However there is a significant gain to be had when guidelines for radiology were adhered by doctors. In a Belgian study, a reduction of 28% in costs overall and 66,7% reduction of radiation exposure from lumbar investigations was achieved by implementing guidelines for radiology alone.[1] In addition, clinical decision support systems (CDSS) have been suggested to reduce overconsumption, inappropriate investigations and further enhance the tools at the disposal of the clinician.

A CDSS is defined by D. Lobach et al as “any electronic system designed to aid directly in clinical decision-making, in which characteristics of individual patients are used to generate patient-specific assessments or recommendations that are then presented to clinicians for consideration”. [9] These can vary from simple reminders and alerts to feedback summaries and interactive modules.

There is already evidence that such computerized clinical decision support systems (CCDSS) for diagnostic tests can modify ordering behaviour and have a positive effect.[10,11] User satisfaction was overall mixed and depended on many system-dependent and -independent factors. This data also showed it could potentially be cost-saving, did not have any major adverse effects or an increase in work time. But these findings were limited and there is a large need for more research about the impact of CCDSS on cost, inappropriate investigations, workflow, patient outcomes and factors that could facilitate the acceptance of such a system by doctors.[10,11]

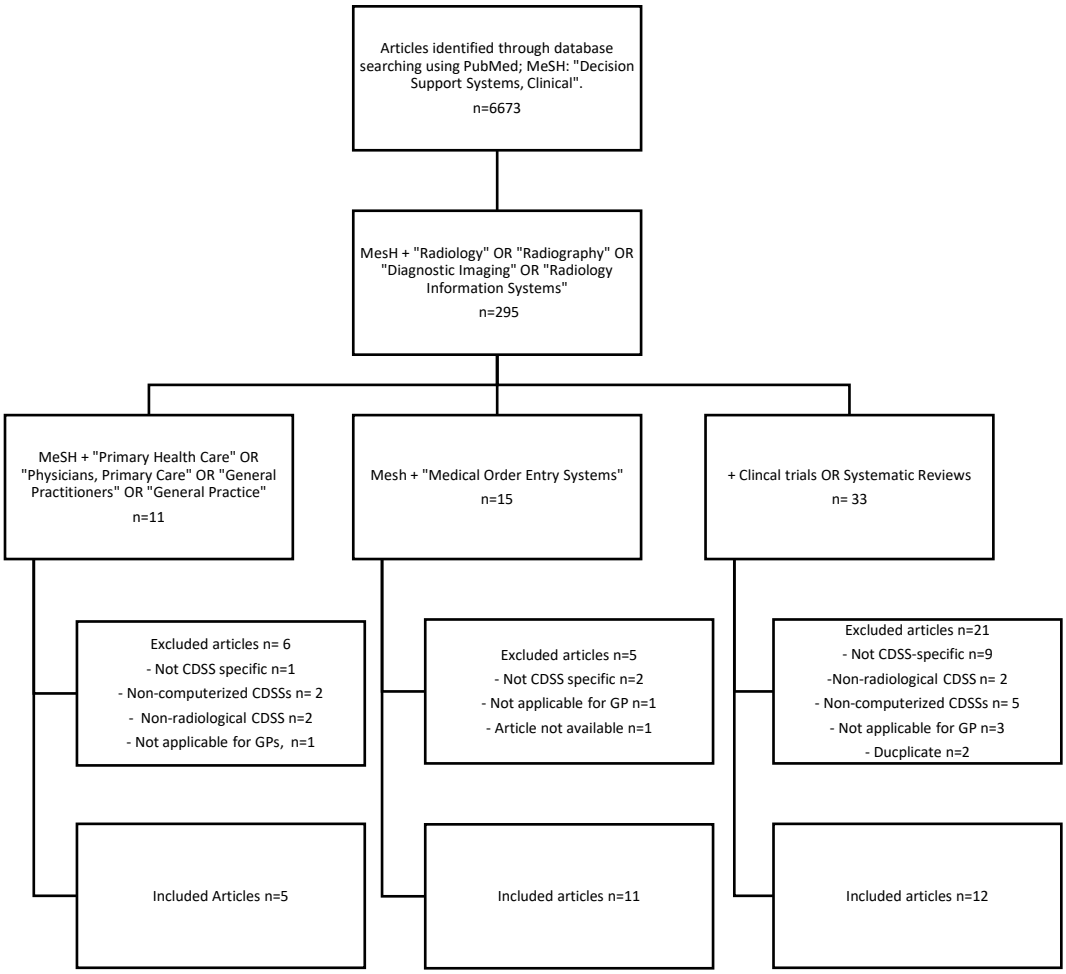
2. Objective

This paper is the preliminary work for a CDSS for radiology in the Electronic Health Record System (EHR), particularly the computerized physician order entry (CPOE) in primary care. We tried to assess the need, acceptance and willingness of the GPs, to use such a proposed system, the possible benefits and pitfalls and tried to delineate a future roadmap for the implementation of a CDSS for radiology in the EHR.

3. Method

3.2 Literature search

A literature search was performed on PubMed with the MESH terms: “Decision Support Systems, Clinical”, “Medical Order Entry Systems”, “Radiology”, “Radiography”, "Radiology Information Systems", “Diagnostic Imaging”, "Primary Health Care", "Physicians, Primary Care”, "General Practitioners" and "General Practice" in order to find previous experiences and results with CDDSs for radiological investigations and available technology for implementing such systems.



3.3 Survey

Following this literature search, a survey was conducted within a population of general practitioners. First, we determined if they had experience with the concepts of CDSS, radiological guidelines and ordering systems. Then we had a section where we asked the GP to rate several items surrounding radiological ordering (consumption, cost, correctness,...), and how a CDSS could potentially have an effect on these matters. We also tried to investigate how the GPs envisioned the implementation of the proposed CDSS, what they expected and where their concerns lied.

Flemish GPs and GPs in training were recruited via the organ responsible for training new GPs in Flanders (Interuniversitair Centrum voor Huisartsenopleiding; ICHO) and via direct electronic contact. The survey was conducted via a Google Form and the data was subsequently exported to an Excel spreadsheet, before being imported into PSPP for analysis. Frequencies, means and standard deviations were calculated with the software and the ratings were subjected to one-sample t-tests.

Each question was then analysed to find differences between subgroups (male vs female, GP vs GP in training, <35 years vs 33-55 years, >35 years). Nominal data was subjected to Chi-squared tests, ordinal data to unpaired t-tests and one-way ANOVA with post-hoc analysis was performed on ordinal data with more than 2 groups. All these tests were performed with 95% confidence intervals.

A full list of our questionnaire can be found in the appendix.

4. Results

4.1 Literature Search

In our literature search, we found a small number of implementations of CDSSs for imaging referral. Most of the systems were only integrated for specific pathologies or used in a specific department, but all were in a hospital setting. Only one covered a more broadly integrated system.[4]

In almost all cases, the CDSS was implemented within a CPOE and only one was specified to be integrated within the EHR.[12] A minority used a web-based CPOE [13,14], another used an intranet-based ordering and scheduling system.[15] Two systems stated they imported patient data, but it was unclear whether or what patient-specific data were extracted from the EHR.[4,13] In all CDSS order forms shown, patient data, history, lab results, possible diagnosis, and indications had to be filled.[14,16–18] If the CDDS imported this data from the EHR is unclear. Where possible data was almost always coded via ICD9 and subsequently processed through evidence-based guidelines, mostly locally derived.

The identified CDSSs used diverse feedback mechanisms. Some showed an appropriateness score for the selected investigation and/or alternative investigations with their scores for the same indication (using the American College of Radiology Appropriateness Criteria®).[4,18,19] Another way of providing feedback was by providing the prescriber with pretest probabilities.[17,20] In only one system the feedback was modal and only a specialist could override the system if they considered it clinically indicated.[16]

There is, however, an interesting project running in Italy under the name of COLLABORADI. It is an EU-funded project that aims to develop a CDSS for GPs based on the Diagnostic Imaging Referral Guidelines (DIRG) that can be implemented in CPOEs and EHRs. These guidelines are focused on the appropriateness of the investigation, the radiation exposure and cost. When presented with a clinical case, its phase (diagnosis or follow-up), the GP is presented with possible investigation methods with their respectable recommendation, grade of evidence, radiation dose classification, priority and waiting time. The system in its current state seems to be an external CPOE.[21]

4.2 Survey

4.2.1 Demographics

The demographic data has been summarised table 1. The 79 responders were all Dutch-speaking Belgian doctors, either GPs or GP-trainees. The exact sample size is unknown as the survey was spread via different channels. Because of this, the percentage of responders is hard to calculate.

	n	Percentage
Gender		
Male	37	46,84 %
Female	42	53,16 %
Age		
< 35 years	38	48,10 %
35 – 55 years	23	29,11 %
> 55 years	18	22,78 %
Role		
GP	51	64,56 %
GP in Training	28	35,44 %
Total	79	100 %

Table 1. Demographic data from the responding GPs

4.2.2 The familiarity with CDSS and Radiologic Ordering Systems

In our survey, we investigated the familiarity that our responders had with the concept of CDSS and electronic ordering systems for radiology. The answers are summarised below in table 2.

	Yes	***No***
Aware of the concept of CDSS	53 *(69,09%)*	26 *(32,91%)*
Used CDSS	24 *(30,38%)*	55 *(69,62%)*
Used electronic CPOE for radiology	19 *(24,05%)*	50 *(63,29%)*

Table 2. The familiarity of the GPs with the concepts of CDSS and CPOE for radiology

Overall 67,09% (n=53) of the responders were familiar with the concept of CDSS. We did not see a statistical difference between age, sex or role. When asked if they had used decision support systems in their practice, 30,38 % (n=24) responded that they did. Here we did notice there were some differences between the ages groups. 28,95 % of the youngest group (n=11), versus 17,39 % of the middle group (n=4) versus 50 % of the oldest group (n = 9) had already used a CDSS. Even though it was statistically significant when we compared the middle group versus the oldest ($p = 0,026$), the absolute numbers were too small to make a definite conclusion. Sex also appeared to have some impact on whether or not the GP's had used a CDSS. 38,10% of the female GP's (n=16) had used CDSS's versus only 21,62% of the male GP's (n=8). This discrepancy, however, was not statistically significant ($p = 0,089$). We cross-tabulated the familiarity with the concept of CDSS and the actual usage of CDSS in their practice and summarised it below in table 3.

	Used CDSS		
Aware of CDSS	***Yes***	***No***	**Total**
Yes	22 *(41,51%)*	31 *(58,49%)*	52
No	2 *(7,69%)*	24 *(92,31%)*	26
Total	24	55	79

Table 3. Comparison of familiarity and actual usage of CDSS in practice.
Only 44,51% of the GPs familiar with the concept actually used them in their practice.

Examples of CDSSs being used by the responders ranged from more common CDSS's for prescriptions, laboratory ordering to several specific tools like the Well's criteria, CHA_2DS_2-VASc, Ottawa rules and so on. Also, some general websites, like the guideline-databases of the Dutch and Belgian GP's (NHG[22], Domus Medica[23]) and CDSS-specific websites, like Option grid[24] and EBMeDs[25] were mentioned.

We further examined if the GPs already used electronic ordering systems and if these systems had some sort of clinical decision support. We found that 24,05 % (n=19) have used an electronic ordering system for imaging. Almost all of them stated that they did their ordering via the EHR, but most did not acknowledge that it had any decision support. The ones that did have decision support, consisted of minimal warning system for allergies, medication or kidney failure.

4.2.3 The need for a CDSS for radiology in the EHR

We asked the GPS to rate the **added value for our healthcare system** (from 1 to 5) that they thought the concepts of CDSS and a proposed CDSS for radiology in the EHR could represent. They rated the concept of CDSS with an average of 3,91 (SD: 0,60), a CDSS for radiology ordering with an average of 3,95 (SD: 0,62) and our proposed system in the EHR with 3,96 (SD: 0,71).

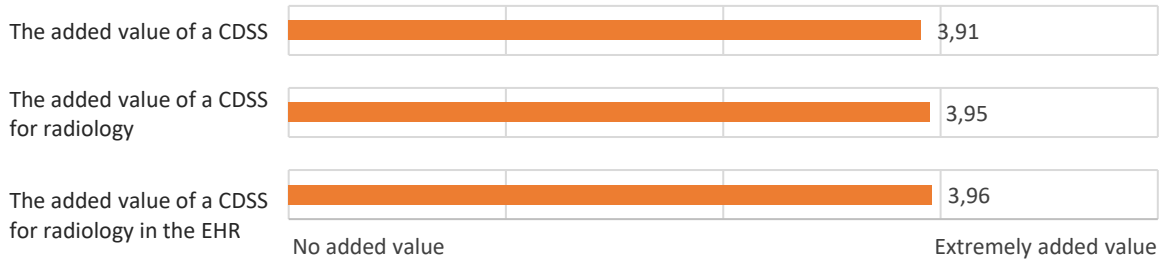


Figure 1. The added value the concept of CDSS, a CDSS for radiology and a CDSS for radiology could represent according to the GPs. (Rated from 1 to 5)

The **consumption** of radiological investigations was rated with an average of 4,30 (SD: 0,67). There was also a significant difference (p = 0,034) between male and female responders, where the females rated the consumption higher (4,45; SD: 0,59) than their male colleagues (4,14; SD: 0,71). When asked how the GPs would rate the **cost** of medical imaging for our healthcare system, they evaluated the cost quite high with an average score of 4,27 (SD: 0,63). The GPs rated the "**correctness**" of radiological investigations as mediocre with an average 3,03 (SD: 0,66).

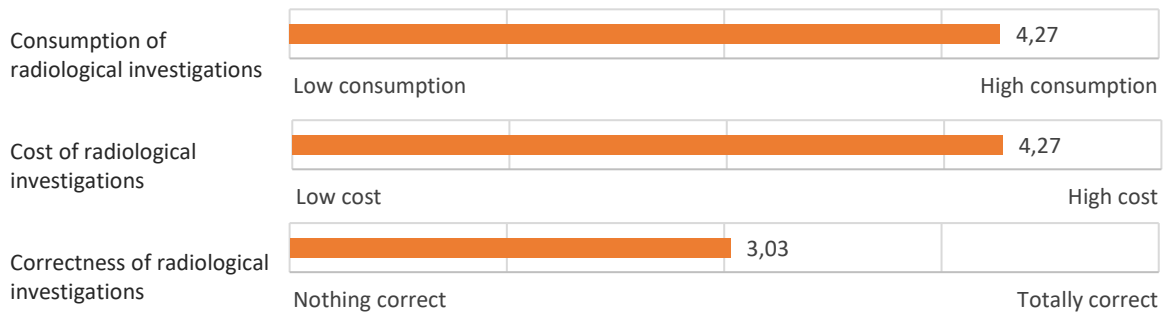


Figure 2. The consumption, cost and correctness of radiological imaging according to the GPs. (Rated from 1 to 5)

We then asked the GPs to rate the possible **effect of a CDSS** on these issues. A CDSS was expected to decrease consumption and rated with an average of 2,20 (SD: 0,74). They also believed that a CDSS had a potential cost-reducing effect with an average score of 2,11 (SD: 0,72) and that a CDDS system would potentially decrease the number of incorrect orderings with a score of 1,85 (SD: 0,66). Here we found a significant difference (p =0,019) when we compared the sexes, where males would rate the potential effect less effective (2,03; SD: 0,76) than the females (1,69; SD: 0,47) in reducing ordering errors.

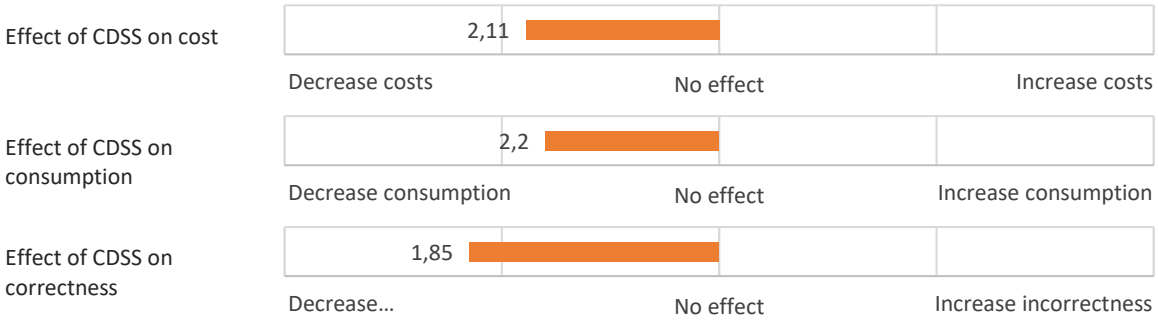


Figure 3. The effect of a CDSS for radiology on consumption, cost and correctness of radiological imaging according to the GPs. (Rated from 1 to 5)

Furthermore, the GPs rated the current **difficulty** of ordering radiology as modestly easy with an average score of 1,94 (SD: 0,97) and the potential effect of a CDSS on ease of use of ordering was rated with 3,16 (SD: 0,97). This effect did not differ statistically significant from a neutral score of 3,00 (p = 0,134).

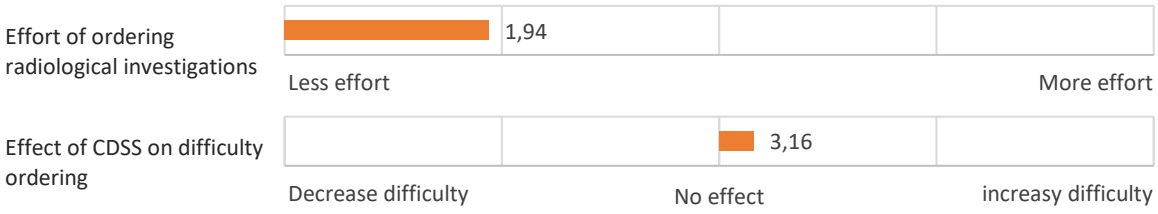


Figure 4. The effort of ordering radiological investigations and the effect of a CDSS for radiology on that effort according to the GPs. (Rated from 1 to 5)

There was a statistically significant difference between age groups and role. The youngest group rated the ordering of imaging harder (2,24; SD: 0,91) compared with the middle group (1,65; SD: 0,78, p =0,09) and the oldest group (1,67; SD: 0,69, p=0,19). Similar statistically significant results (p = 0,016) were found when we compared the GPs in training (2,25; SD: 0,97) versus the GPs (1,76; SD: 0,76).

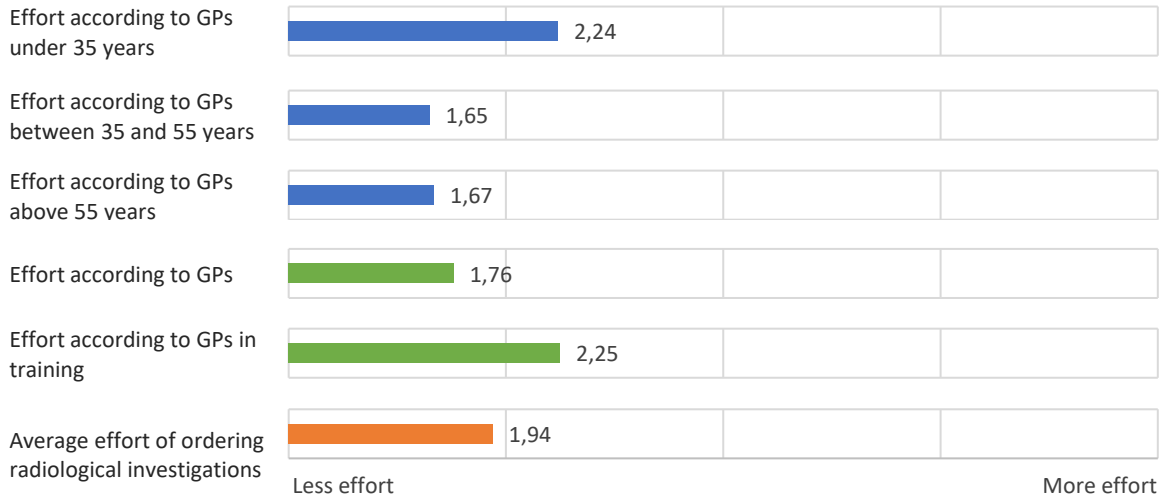


Figure 5. The effort of ordering radiological investigation according to the GPs, compared by age groups and role. (Rated from 1 to 5)

The GPs rated their own **need for feedback** when ordering medical imaging with an average 3,89 (SD: 0,89) and how a CDSS could potentially meet this need for feedback with an average of 3,61 (SD: 0,74).There was a trend that younger, lesser experienced and female responders experienced more need for feedback, though this was not statistically significant. Paradoxically we saw a trend that the groups that felt a greater need for feedback rated the potential effect of a CDSS slightly lower in providing this feedback. But this only proved to be statistically significant (p = 0,47) when we compared females (3,45; SD: 0,86) to males (3,78; SD: 0,53).

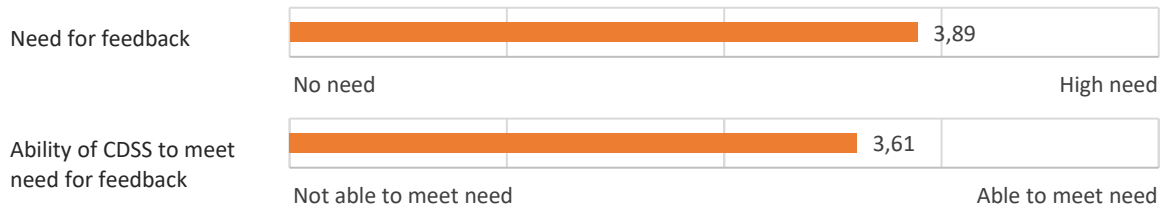


Figure 6. Need for feedback of GPs when ordering radiological investigations and how much a CDSS could potentially meet that need for feedback. (Rated from 1 to 5)

We also asked them how many used **radiologic guidelines** in their practice when ordering imaging. We found out that 68,35% (n=54) did not use or consult radiological guidelines in their practice.

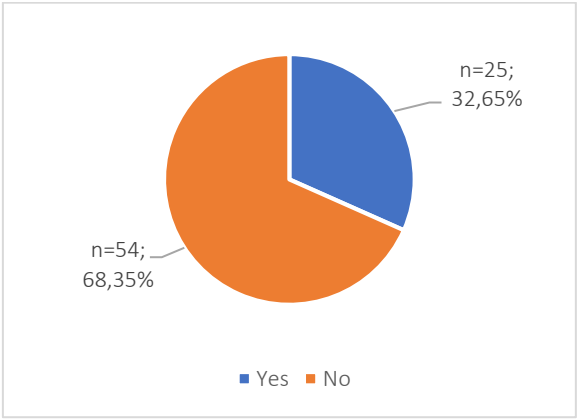


Figure 7. Usage of guidelines for radiology among GPs.

4.2.4 The Role of the EHR

When asked how that they thought a radiological ordering system with CDSS should be developed, 93,67% (n=74) felt it had to be integrated within the EHR. In this group 74,32% (n=55) imagined a central location within the consultation screen via a button or tab, while 22,97% (n=17) thought it was more suited within the menu system, two persons did not specify where in the EHR it had to be implemented. In the group that did not think the ordering system for radiology with CDSS should be implemented in the EHR (6,33%, n=4), 3 chose an external program and only one thought a website would be better suited. One answer was redacted because of ambiguity.

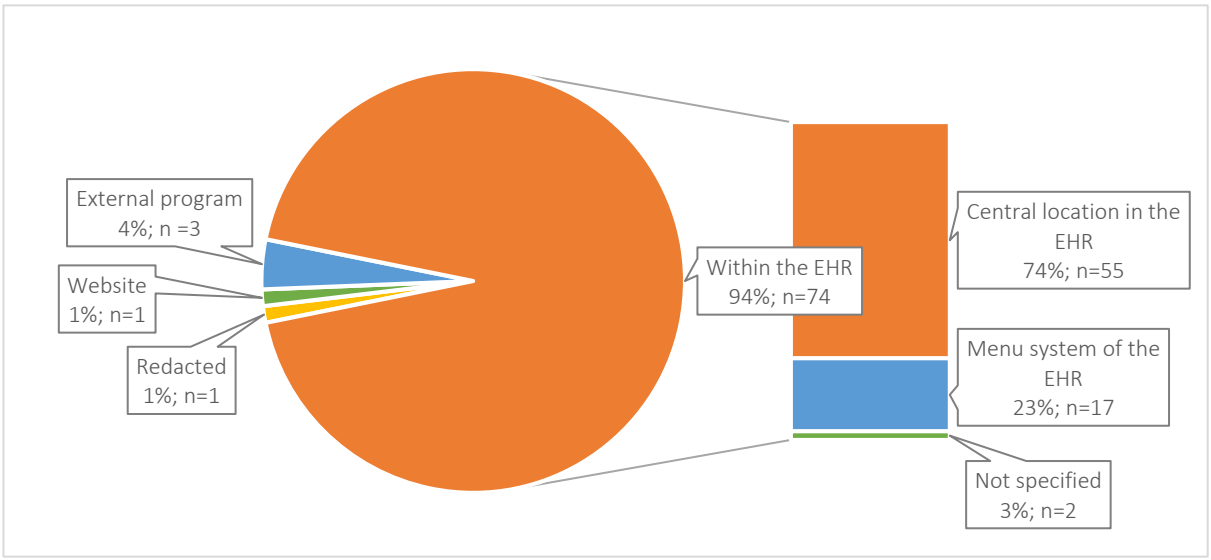


Figure 8. Location where the GPs thought a proposed CDSS for radiology should be implemented.

When the question was raised what kind of feedback they wanted from a CDSS when ordering imaging tests, 93,67% (n=74) wanted alternatives for their chosen imaging given a specific pathology, 81,01% (n=64) wanted to have warnings about dangers when ordering certain tests for a specific patient and 68,35% (n=54) wanted to know statistical information about the imaging tests for a specific pathology.

Other feedback suggested by the GPs were cost, radiation exposure, waiting time, the need for preparation, if there even was an indication for imaging or not and a possibility to audit.

4.2.5 Possible pitfalls and concerns

When directly asked only 3,8% (n=3) answered that they had none concerns or did not foresee any pitfalls. A large majority feared there would be a problem with too little-coded data in EHR for the CDSS (73,4%; n=58) or that we would put too much faith into software instead of clinical thinking (69,6%; n=55). 38,0 % (n=30) of the responders suspected it could potentially be too time-consuming with the extra administration and 15,2% (n=12) worried about potential interference from outside in their clinical decision making. We also noticed the repeated concerns of the GPs of an unwieldy system, "too many clicks" and the workload of a well coded EHR could hinder the actual usage in practice.

When we asked to rate the amount of data in their EHR that they coded (medical history, diagnosis, treatment,..), the average rating was 3,75 (SD: 0,94). They rated their EHR "completeness" (chronic medication, medical history, allergies,..) with an average rating of 3,71 (SD: 0,86).

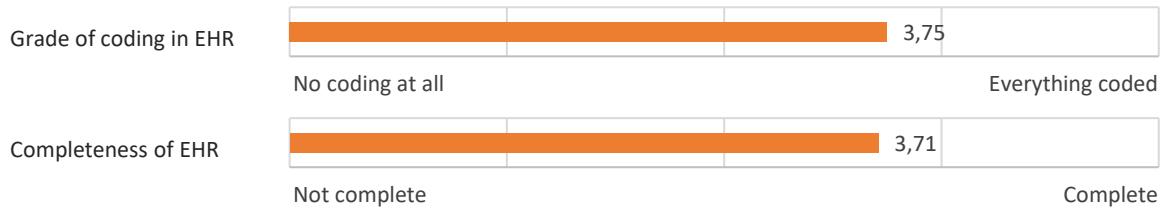


Figure 8. The grade of coding and completeness of their EHR, as rated by the GPs. (Rated from 1 to 5)

If there was a CDSS for radiological ordering that would be perfectly integrated within their EHR, 98,73% (n=78) would use such a system in their practice.

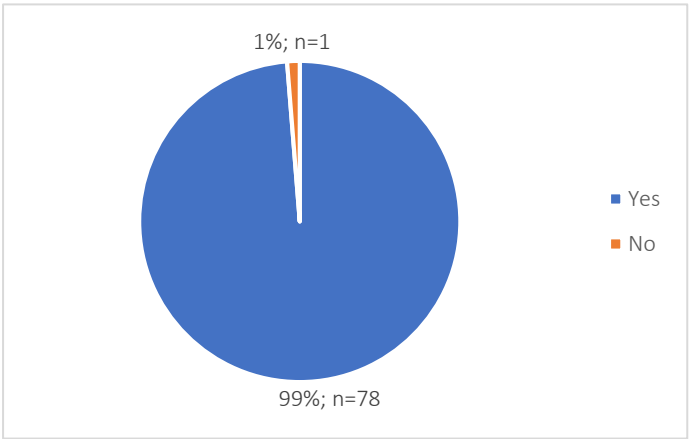


Figure 9. Percentage of GPs that would use a proposed, adequate CDSS for radiology in the EHR.

5. Discussion

5.1 What has been used already?

In our literature search, we found only a small number of cases where there they tested a computerized CDSS for imaging referral. Most of them were only for specific pathologies or departments within the hospital. Only one of the systems covered a more broadly implemented system.[4] We did, however, find an interesting project running in Italy, under the name of COLLABORADI. It aims to develop a CDSS specifically for GPs, using the Diagnostic Imaging Referral Guidelines (DIRG), that can be implemented into CPOEs and EHRs.[21]

Among the questioned GPs the awareness of the concept of CDSS was moderate-high (65,82%), however, the actual use of them in practice was only limited to less than half this group or 30% of all the GPs. The only CCDSSs in the EHR were for prescriptions and laboratory ordering. General websites, like the guideline-databases of the Dutch and Belgian GP's (NHG[22], Domus Medica[23]) and CDSS-specific websites, like Option grid[24] and EBMeDs[25] were also mentioned. Furthermore, specific tools like the Well's criteria, CHA_2DS_2-VASc and Ottawa rules were also used.

While a quarter of the responders had already used CPOE-system for radiology, a CCDSS for radiology implemented In EHR for primary care physicians was mostly absent or very minimalistic, following our findings in literature.

5.2 Are there goals that are sensitive to a CDSS?

5.2.1 Consumption of medical imaging

The number of radiological investigations performed is rising because of a multitude of factors. Our GPs affirmed this in the survey, stating there is a heavy overconsumption. They also thought that a CDSS could have a positive effect and decrease this consumption. A number of studies have tried to confirm this thought. Their results were overall positive with a decrease in investigations [16,18,20,26] or a decrease in growth of investigations [4,15]. But as already stated these studies were mostly limited in scope and not applicable to a GP-environment.

5.2.2 Cost of medical imaging

The cost of medical imaging has followed the consumption and increased over the years. Now forming a significant part of the healthcare budget, especially in Belgium.[6] Our GPs also affirmed this by rating the cost of medical imaging to be very high and again thought the proposed CDSS could decrease these costs. There haven't been many studies on the effect of CDSSs on cost, and none we could find for radiology.

Studies on the effects of CCDSS on the cost of other diagnostic test orderings showed mixed results.[10] One study did, however, suggest that presenting doctors with the cost of a radiological investigation could have an effect on their choice.[27] Most promising was a study that showed a cost reduction of more than a quarter when implementing radiology guidelines alone.[1] As we found that less than a third of our responding GPs actually used guidelines to order radiological investigations, this could be promising and a stimulus for our proposed system.

5.2.3 Appropriateness of medical imaging

Besides the rising cost and consumption, there is also the problem of inappropriate imaging, where no imaging is needed or a wrong examination has been requested. One study found that 71% of the CTs for lumbar investigation was unwarranted and that GPs ordered significantly more inappropriate investigations than other specialist doctors.[1] Our GPs rated that the "correctness" of imaging as mediocre and found that our proposed system could help in the decrease in incorrect imaging. They

rated this potential effect higher than its potential effect on cost and consumption. There was however only limited research done on this topic. Some saw an increase in positive imaging after implementing a CDSS for radiology [20,26], which could mean more appropriate imaging, but it remained speculative.

5.2.4 Radiation exposure

Another potential factor that could be sensitive for a CDSS for radiology is radiation exposure for patients. Research suggests that showing the expected exposure before ordering [19,27,28] or guidelines [1,19] could help decrease the radiation exposure for patients.

5.3 What do the GPs want from a CDSS

We found that the GPs have a quite high need for feedback when ordering imaging and that they rated a CDSS quite capable as an answer to this need. If we look what kind of feedback they wanted, almost every GP wanted to see alternative, more appropriate imaging solutions for a given specific pathology and a warning system. Another large portion of the responders wanted statistical information (specificity, sensitivity, pre- and post-test odds, likelihood ratios,…). Other interesting feedback suggested by the GPs was the cost for the patient and healthcare, the amount of radiation exposure, waiting time, the need for preparation, if there even was an indication for imaging or not and a possibility to audit the system. Research has shown that we can possibly facilitate the usage of a CDSS if we have a reliable system, where the doctors have control over content and frequency of feedback shown by the CDSS.[29]

5.4 Pitfalls and barriers

In our survey, only 3,8% had no concerns or did not foresee any pitfalls. Technical problems or difficulties could be threatening for the acceptance of a CDSS. Previous experiences with faulty systems were shown to be a potential barrier [29] and our survey showed a large concern amongst the GPs over an unwieldy system. Another hurdle could be the added workload when ordering imaging. Though our survey did show that our GPs found it quite easy to order imaging and a CDSS would have no effect on the difficulty. Limited research on other diagnostic CDSS systems confirms that it did not have a negative effect on workflow.[10] Furthermore they feared the workload of a well-coded EHR. But this also could prove to be less of a problem as they thought as they graded of the completeness of their records with an average score of respectively 3,75 and 3,71. Other concerns were expressed that we would possibly put too much faith in software instead of clinical reasoning or it would hurt the doctor-patient relationship. Only a minor fraction of our survey was worried about interference in their clinical decision making.

5.5 Possible acceptance of a CDSS for radiology

The possible acceptance of the system could be quite high as the GPs found it to be an added value for our healthcare system and almost all the GPs (98,73%) would use a hypothetical, perfect integrated CDSS for radiological ordering in their practice. Reasons stated against using such a system were lack of time, if it were an unwieldy process with too many clicks, the workload of a well coded EHR, unavailability when performing house visits and the added distance it creates between patient and doctor.

5.6 Future Perspective

This study concludes but only the first step of a CDSS for radiology implemented in the EHR. Here we try and paint a future roadmap for the further implementation of a CDSS in the EHR.

When designing a CDSS for radiology in the EHR we refer to frameworks or tools, such as developed as part of the GUIDES project [30] to help create and assess the performance of a CDSS. First, we need to identify which input parameters are needed by the CDSS. The CDSS will need passive data as in patient information (e.g. age, medication, history, lab results,...) and active data the GP needs to fills in (requested investigation, differential)diagnosis, clinical examination,…) to feed into the algorithm. To be useful a large part of the data needs to be coded (e.g. ICD-10, IBUI, ICPC-2,…) and the algorithm needs to be able to handle a broad selection of coding systems. The backbone of the CDSS are the guidelines. Important is that they are up to date and contain high quality of recommendations. Tools are available to grade the quality of these recommendations, like the AGREE tool [31]. As it could be labour-intensive to convert these recommendations to scripts, implementing the most important ones, in the beginning, could be beneficial in the early stages of the project. The mentioned GUIDES framework has a tool for prioritizing which recommendations to implement. When the algorithm has interpreted the data, feedback could be provided with the ACR Appropriateness Criteria®, alternative/better investigations and warnings about contraindications for the investigation. Coupling with knowledge databases or other sources could provide the GPs with needed statistical information, radiation exposure, costs, information to give to the patient or even estimated waiting times. The collection of data for further research could also be an interesting idea.

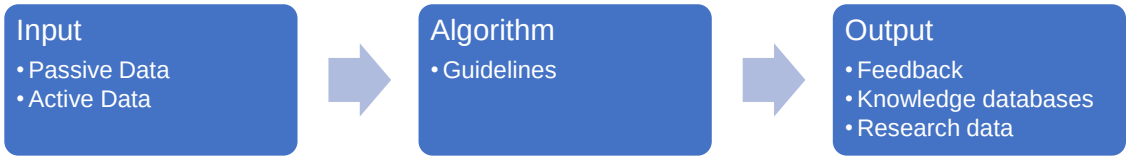


Figure 10. Simplified CDSS

For the implementation of this system, we refer to our results where the majority of the GPs found it should be implemented within the EHR, preferably in a central location within the consultation screen. As the landscape of EHR in Belgium is rather fractured in multiple software systems, a common ground could be the usage of eForms. It should be noted that in every step of design and implementation the principles of user interface design should be considered as the GPs in our survey stated that an unwieldy, labour-intensive process could prevent them from using it and they feared a system like this could create a schism between them, the patient and their clinical thinking.

As Jeff Raskin said in his book *"The Humane Interface"* there are two laws in user interface[32]:

> *"First Law: A computer shall not harm your work or, through inactivity, allow your work to come to harm.*
>
> *Second Law: A computer shall not waste your time or require you to do more work than is strictly necessary."*

As further studies are essential, the implementation of the proposed system in a number primary care practices could give insightful information about its suspected abilities. Pre- postimplementation comparison or comparison with a control group could provide hard data about the effects on ordering behaviour and confirm its positive effects. Additional surveys and feedback of the GPs could help iron out design-flaws and improve ease of use.

6. Limitations of the study

This study is largely based on the opinion of responding Belgian GPs on how a CDSS for radiology in the EHR could function, their thought on how it might improve our healthcare system and what pitfalls may lie ahead. There could be a bias in the selection of candidates as most of them were recruited via ICHO and are heavily involved in the training of new GPs. Further research is needed to measure the actual effect on these issues and effectiveness of such a system.

7. Conclusion

In our literature study as well as in our survey, we did not manage to find much evidence of a broad CDSS for radiology implemented In EHR for primary care. Only the COLLABORADI project did seem like a very interesting tool to follow up on.

From the results we gathered from our survey, we saw a strong acceptance to use a CDSS for radiology that was perfectly integrated into the EHR. The GPs also thought it would have a beneficial effect on reducing overconsumption, cost and errors. Some limited evidence in literature confirms this and suggest that these issues could be sensitive for a CDSS. The GPs also found a CDSS to fulfil the need for feedback when ordering radiology that they expressed in the survey. Barriers to use such a system were found in the ease of use, added workload and coding of the records. It was repeated several times over that an unwieldy system, “too many clicks” and the workload of a well coded EHR could well stop the GPs from even using a perfectly integrated system.

The actual effect of such a system needs to be proven with hard data and further research. But the benefits of implementation of radiological guidelines alone have been shown to be quite substantial. And with our finding that only a third of the GPS use radiology guidelines, this could prove to be true.

These findings in whole should serve as a stimulus to develop a CDSS for radiology in the EHR of primary care physicians.

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Appendix

Questionnaire

This questionnaire has been translated from Dutch to English for this paper.

Question	Possible Answers
What is your age?	Multiple choice: • <35 years • 35-55 years • >55years
Are you a GP in training?	Yes/No
What is your gender?	Male/Female
Which EHR-software do you use?	Free field
Where you aware of the concept of CDSS, before this survey?	Yes/No
Do you use guidelines for radiology?	Yes/No
⇨ **Which guidelines for radiology do you use?**	Free field
To what extent do you think CDSS has an added value for our general healthcare system?	From 1 (no added benefit) to 5 (Extremely large added benefit)
To what extent do you think CDSS <u>for radiological ordering</u> has an added value for our general healthcare system?	From 1 (no added benefit) to 5 (Extremely large added benefit)
To what extent do you think CDSS for radiological ordering <u>in the EHR</u> has an added value for our general healthcare system?	From 1 (no added benefit) to 5 (Extremely large added benefit)
Have you worked with CDSSs?	Yes/No
⇨ **Which CDSSs have you used?**	Free field
Have you worked with electronic ordering systems for radiology?	Yes/No
⇨ **Which ordering systems for radiology were these, and did it have a CDSS?**	Free field
How would you rate the consumption of radiological investigations in our society?	From 1 (Underutilization) to 5 (Overconsumption)
Do you think a CDSS would lead to more or fewer investigations?	From 1 (Fewer investigations) to 5 (More investigations)
How would you rate the correctness of radiological investigations in our society? (e.g. correct information, correct question, correct investigation for the pathology,..)	From 1 (None or very little incorrect ordering) to 5 (Largely incorrect ordering)
Do you think a CDSS would lead to less or more incorrect ordering?	From 1 (less incorrect ordering) to 5 (More incorrect ordering)
How would you rate the costs of radiological investigations in our society?	From 1 (very low costs) to 5 (very high costs)
Do you think a CDSS would lead to an increase or decrease in costs for radiological investigations?	From 1 (Fewer costs) to 5 (Higher costs)
How would you rate the effort you have to make to order radiological investigations?	From 1 (Very low effort) to 5 (Very high effort)

What change do you think a CDSS would have on the effort you have to make while ordering radiological investigations?	From 1 (Less effort) to 5 (More effort)
How much need for feedback do you have while ordering radiological investigations? (e.g. specificity/sensitivity, right investigation for the pathology with(out) contrast, warnings,…)	From 1 (No need for feedback) to 5 (High need for feedback)
What feedback would you want from a CDSS for radiology?	Multiple choice (multiple answers possible) • Alternative/better investigations for my differential diagnosis • Statistical information (e.g. sensitivity/specificity for my differential diagnosis • Warnings about potential dangers for my patient (kidney failure, allergies,…) • Other: Free field
To what extent do you think a CDSS is capable of providing the feedback that you want?	From 1 (Not capable at all) to 5 (Totally capable)
Where would you place an ordering system for radiology with CDSS?	Multiple choice: • Within the consultation screen of the EHR. (Button or tab) • Within the menu system of the EHR. • Within an external program • Within a site • Other: free field
How would you rate the completeness of your electronic patient files? (chronic medication, medical history, allergies)	From 1 (Not complete) to 5 (Complete)
To what extent do you code data in your EHR? (medical history, diagnosis, treatment,..)	From 1 (Nothing is coded) to 5 (everything is coded)
What pitfalls could be present when using a CDSS for radiology? What concerns would you have when using	• Not enough coded data available in the EHR • Interference from outsiders or institutions in my practice of medicine • Extra administration • Too much reliance on software instead of clinical thinking • None • Other: free field
If there was a perfectly working CDSS for radiology, integrated into the EHR, would you use it?	Yes/No
⇨ **Why wouldn't you use this perfectly working CDSS for radiology, integrated into the EHR?**	Free field

Approval Ethical Committee

Gunstig advies van OBC 1

	Reg. nr.	Titel van de studie	Status	Beheer
	mp19759	Implementation of radiology guidelines through CDSS in the EHR. **Student(en):** Steven Tokarek **Promotor:** Bert Aertgeerts	Gunstig advies van OBC	

Gunstig advies van OBC

2017-04-26 16:04:36

Bekijk status geschiedenis

De OBC heeft, na overleg met en toelichting door de promotor, beslist om deze aanvraag goed te keuren

Student(en): Steven Tokarek
Promotor: Bert Aertgeerts (bert.aertgeerts@kuleuven.be - u0002409 - Acad. Centr. voor Huisartsgeneeskunde)
Faculteit: Geneeskunde
Opleiding: Master in de huisartsgeneeskunde (Leuven e.a.)
Het onderzoek is: monocentrisch
De opdrachtgever is: academisch (universiteit,...)
Het onderzoek is: Literatuurstudie.

BIJKOMENDE GEGEVENS:

Achtergrond:

Evolution in usage of radiological investigations
The utilization of radiological investigations has increased the last several decades. This evolution can be explained in part by the aging population, the growing number of radiologists and an expanding list of indications. The surge of technological advances in the field also provided an increase in choice, safety and availability of certain investigations. Studies also found potential factors that influence the behaviour of the referring physician: including the patients expectations, an increase in assertiveness, knowledge and trust in technology by patients, the uncertainty of the physician, defensive medicine, fear of legal prosecution and economic motives.1–5
This increase in radiological investigations has proven to have a significant impact on health care budgets, longer waiting lists and an increase in radioactive exposure for the population despite lower radiation exposure per investigation.1,6 Another problem these factors may contribute to is wasteful investigations: repeat investigations, investigations with insufficient clinical information or unclear questions, investigations where the results have no effect on therapy, too often or wrong investigations, and over-investigation.1,2,7
Attempts have been made to reduce this overconsumption, including information campaigns, audits, feedback and financial incentives. Unfortunately, after analysis these interventions had only minor positive effects, if any at all.1,5,8 In addition, clinical decision support systems (CDSS) have been suggested to reduce overconsumption, inappropriate investigations and further enhance the arsenal of the clinician.
Clinical decision support systems
A CDSS is defined by D. Lobach et al as *"any electronic system designed to aid directly in clinical decision-making, in which characteristics of individual patients are used to generate patient-specific assessments or recommendations that are then presented to clinicians for consideration"*. 9 These can vary from simple reminders and alerts to feedback summaries and interactive modules.
The scope of this paper will be limited to CDSSs for radiology ordering in the Electronic Health Record System (EHR), particularly the Order Communication Systems (OCS).

Vraagstelling: In what way could a CCDSS for radiology be efficiently and effectively implemented in the EHR for the general practitioner?

Methodologie: In order to find used CCDDSs for radiological investigations and available technology for implementing such systems a literature search wil be performed on pubmed.
Following this literature search a survey could be conducted within a population of general practitioners to determine the experience with the concept and potentially anticipate needs and/or pitfalls when implementing this sort of CCDSS.
With this information we will try and design the building blocks for an "ideal theoretical model" to implement a CCDSS for radiological investigations within the EHR system.

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Informed consent / vragenlij...