Budget impact analysis of abdominal ultrasound in Dutch primary care

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Abstract

Background: The transition of diagnostic ultrasound to general practice serves as alternative to traditional hospital-based ultrasound examinations. This study's objective was to investigate this transition, by evaluating the impact of abdominal ultrasound on hospital referrals and healthcare costs in general practice, hospital care and diagnostic treatment centres (DTCs).

Methods: A budget impact analysis was conducted using reimbursement data from a health insurer's perspective. Ultrasound reimbursement claims and diagnosis treatment combinations were compared between general practices, hospitals and DTCs for approximately 52,000 patients. In addition, eleven semi-structured interviews were performed to identify the opinions and experiences of general practitioners (GPs) and radiologists towards ultrasound examinations in general practice.

Results: Considering a 6- and 12-week time horizon, lower referral rates were found for patients receiving ultrasound in general practice (15% and 19%) relative to patients receiving ultrasound in hospital care (20% and 25%) and DTCs (18% and 22%). In addition, average ultrasound costs per patient as well as average treatment costs per patient < 12 weeks were lowest for patients from general practice. Important preconditions mentioned by GPs and radiologists for performing ultrasound examinations in general practice entail archiving and reporting of images in an electronic health record, the availability of a patient's medical history data and intensive collaboration between a GP and radiologist.

Conclusions: Abdominal ultrasound in general practice leads to lower costs compared to abdominal ultrasounds performed in hospitals and DTCs, caused by the use of different reimbursement tariffs for ultrasound examinations and fewer referrals to specialist care. As this study only focussed on the financial impact of abdominal ultrasound in primary care, further studies are needed to investigate the impact of diagnostic ultrasound from a broader perspective such as its effects on health outcomes.

Keywords: Abdominal ultrasound, budget impact analysis, general practice, patient management, primary care

Introduction

While healthcare expenditure in the Netherlands has been rising consistently over the past few years (1,2), more and more cost-cutting measures and reforms of care systems are used to control and steer costs. A recent report published by the Organisation for Economic Co-operation and Development (OECD) states that an often neglected aspect in controlling health expenditure is reducing ineffective spending and waste. Waste has been defined by the OECD as “care that could be produced using fewer resources within the system while maintaining the same benefits” (3). A study by Visser *et al.*, (2012) states that 20% of the budget for acute care could be saved by reducing overutilization, reinforcing primary care and increase the integration of care (4). Substitution of care is one of the proposed solutions by the Dutch Ministry of Health, Welfare and Sports to keep healthcare affordable and to reduce health costs in secondary care (5,6). A study by the Dutch Institute for Health Services Research (2016) in which the potential ways for substitution between primary and secondary care were examined, showed that a more intensive use of primary care leads to a reduction of patients in secondary care (6). The transition of diagnostic ultrasound from specialist care to general practice is an example of moving activities from secondary care to primary care.

Ultrasound examinations are used for evaluation of abnormalities of superficial and deep organs of the body as well as for screening and diagnosis of occult diseases (7). Currently, ultrasound examinations in primary care are performed in general practices, hospital care and diagnostic treatment centres (DTC, i.e. private healthcare institutions). A flowchart of the patient pathway concerning these three options in primary care is provided in Appendix 1. Considering the various types of offered ultrasounds in primary care, abdominal ultrasounds are performed most frequently (42%), followed by musculoskeletal ultrasounds (lower extremities (17%), upper extremities (12%)) and breast ultrasounds (9%) (internal data of Dutch health insurance company Menzis). Diagnostic accuracy (i.e. sensitivity, specificity, positive and negative predictive values) of ultrasound varies between different types of ultrasounds (8). Since abdominal ultrasound represents the majority of all performed ultrasounds, this study focusses specifically on the substitution of this type of ultrasound from secondary to primary care. Several indications for the reimbursement of abdominal ultrasound in general practice are defined by the Dutch Healthcare Authority (NZa) in a Modernization and Innovation (M&I) service, a financing form for small operations or specific diagnostic examinations performed by a general practitioner (GP), as can be seen in Table 1.

Table 1. Medical indications M&I service "abdominal ultrasound" (9)

Organ	Medical condition
Aorta	Recognizing of aneurysm
Liver	Tumours, metastases
Gall bladder	Gall stones, impetus
Kidneys	Impetus, concrements, cysts, tumours
Uterus	Myomen, position of IUD, endometrium thickness
Ovaries	Cysts
Bladder	Bladder retention, concrements

This table shows the indications per organ that are suitable for abdominal ultrasound imaging by a certified GP in general practice.

Since GPs often perform less extensive examinations than radiologists, they - in general - use portable or point-of-care equipment which is less advanced and less expensive compared to hospital equipment. Differences between hospital equipment and point-of-care equipment mostly concerns probe quality, image quality and ICT possibilities (10,11). Previous studies comparing diagnostic agreement and consistency of medical findings between radiologists and GPs performing low-complex abdominal ultrasounds, showed almost perfect agreement (Kappa index of respectively 0.93 and 0.89) (12–14). For this reason, it is assumed that medical findings of GPs and radiologists on low-complex ultrasounds are comparable and no clinically relevant findings are missed by GPs.

When considering the accompanying impact on patient management, previous research has shown that abdominal ultrasound examinations in general practice could lead to fewer referrals to medical specialists, as well as to reassurance of patients (15,16). Wordsworth and Scott (2002) showed that expensive consultation costs of medical specialists could be prevented, due to a decrease in hospital referrals (17). It is however unclear whether this leads to actual savings in healthcare costs, since the availability of ultrasound in general practice might also lead to excessive imaging and overtreatment of benign incidental findings (7,15). Considering differences in cost prices, ultrasounds performed in general practice are less expensive compared to ultrasounds performed in hospitals or DTCs, mainly due to the absence of a medical specialist in general practice (~€56/patient in general practice vs ~€84/patient in hospital care in 2016 (18,19)). Except for the study of Wordsworth and Scott (17), evidence about cost differences in secondary care is lacking.

In addition, there are a number of factors that could moderate the use and quality of ultrasound in general practice. The Executive Council of the European Society of Radiology (ESR) emphasizes that communication about the clinical history and potential diagnosis of the patient between the GP and radiologist is essential to validate imaging examinations in general practice (20). Besides the communication aspect, a further challenge of performing ultrasound scans in general practice is the lack of quality standards. Apart from the recommendations published by the Dutch society of Generalist-Sonographers (VVHE), no quality standards concerning ultrasound examinations in general practice exist (21). Known recommendations given by the VVHE include the required frequency of the probe (3-5MHz for abdominal probes), required ICT (storage of images needs to be possible in the cloud or on an external hard drive) and the minimal annual turnover of ultrasound examinations (100 examinations per year to be eligible for re-registration as GP-sonographer) (21). Besides the issues mentioned above, a cross-sectional survey amongst GPs from different countries/regions in Europe by Mengel-Jørgensen *et al.,* (2016) describes barriers considering the usage of ultrasound in general practice (22). Lack of reimbursement and time for performing ultrasound as well as the lack of training about ultrasound devices are seen as obstacles by GPs to start with ultrasound. Unlike the factors mentioned above, no study has yielded specific requirements for performing abdominal ultrasound in general practice whereas the availability of diagnostic ultrasound in primary care is growing (10,23). This poses the question if diagnostic ultrasound is actually suitable for general practice. Therefore, insights into the budgetary impact of abdominal ultrasound in Dutch general practice as well as prerequisites for performing ultrasound in Dutch general practice may help both clinicians and policy makers in providing good quality of care.

The main question addressed in this article is whether performing abdominal ultrasound in general practice leads to a reduction in healthcare costs. Secondly, preconditions according to GPs and radiologists required for ultrasound examinations in general practice will be studied. The outcomes of this article are of interest to health insurance companies during the development of purchasing policies on the reimbursement of imaging diagnostics in primary care. Besides that, the findings of this article can be used by GPs and radiologists in gaining a better understanding of the use of ultrasound in primary care.

Methods

A budget impact analysis (BIA) was performed in Microsoft Excel (version 2010) to evaluate the budgetary implications of abdominal ultrasound in general practice relative to abdominal ultrasound in hospital care and DTCs. Although, in general, comprehensive economic assessment of new healthcare interventions requires both a cost-effectiveness analysis (CEA) and a BIA (24), it was assumed there were no considerable differences in health outcomes between the three options in primary care. Therefore, this study only focussed on the impact on costs. Guidelines from the International Society for Pharmacoeconomics and Outcomes Research (24) and recommendations from the Dutch National Healthcare Institute (25) were followed during this analysis. The analysis was performed from the perspective of a Dutch health insurer (Menzis) representing approximately 2.2 million insured persons in 2016 in the Netherlands (26). Everyone insured at Menzis agrees, by taking out health insurance, with the fact that their personal data may (anonymously) be used for scientific and statistical analysis. Ethical approval from a medical ethical review committee was therefore not required. The study was however approved by the ethics committee of the faculty of Behavioural, Management and Social Sciences of the University of Twente.

To calculate the costs of the ultrasound examinations, ultrasound reimbursement tariffs were used (Table 2). Since costs for equipment, staff, ICT and overhead are paid via the reimbursement tariffs and therefore not directly by a health insurance company, these costs were not taken into account in the analysis. To calculate the costs accompanying a referral to specialist care, "diagnosis treatment combinations" (DBCs) were used (27). By summing the costs of all DBC products per patient that were related to medical specialities that treat abdominal disorders, costs for any subsequent treatment in secondary care were taken into account. To evaluate the impact of abdominal ultrasound on referrals to specialist care, at first, a referral time of six weeks was chosen since this involved the average waiting time for outpatient care in 2016 (28). In addition, a referral time of twelve weeks was chosen for two reasons: firstly, at this point the number of referrals to specialist care was strongly declined (Appendix 2), and secondly, this allowed to evaluate the impact on referrals to specialist care for a longer time horizon.

Table 2. Costs of the included ultrasound products in the analysis

Type of care	Code	Name	Costs (€)
General practice	13045	M&I service abdominal ultrasound	€55.83 (18)
Hospital care and DTC	087070	Examination of abdominal organs through ultrasound	€83.51 (19)

This table shows the ultrasound examinations that are used in either general practice or hospital care/DTCs for reimbursement claims as well as their corresponding codes and costs.

Analysis time horizon

The analysis was conducted using health insurance declaration data, out of which the number of performed ultrasounds by GPs, hospitals and DTCs were extracted as well as frequencies of the opened DBC products in specialist care. As DBC declaration data of 2017 and 2018 were not available or incomplete at the start of the study, 2016 was considered to be the most recent representative year available and was therefore used for the analysis. Since the time horizon of the analysis did not exceed one year, no discount rate was applied.

Target population

A population including approximately 52,000 patients was obtained by selecting all patients that received one of the included ultrasound examinations in 2016 (see Figure 1). Patients referred to secondary care were selected by only including patients with at least one registered DBC-product in secondary care. Subsequently, only patients that were referred to medical specialties which treat abdominal abnormalities (i.e. gastroenterology, geriatrics, gynaecology, internal medicine, neurology, radiology, urology, vascular surgery) were included (29–33). Thereafter, all patients under eighteen years of age were removed, as this group was so small it was considered negligible (367 patients,

1,4%). Further selection was based on including patients whereby referral to specialist care took place after the day the ultrasound was performed and in which referral happened within six or twelve weeks. In the final step of the data selection, all patients referred to geriatrics, neurology and radiology as well as several diagnoses that did not relate to abdominal problems were excluded since they showed too little agreement with the medical indications in Table 1 (29–33). The goal of these last two steps was to only select patients in whom the referral was a direct consequence of the findings on the ultrasound examination in primary care. An overview of the excluded medical specialties and diagnoses is provided in Appendix 3.

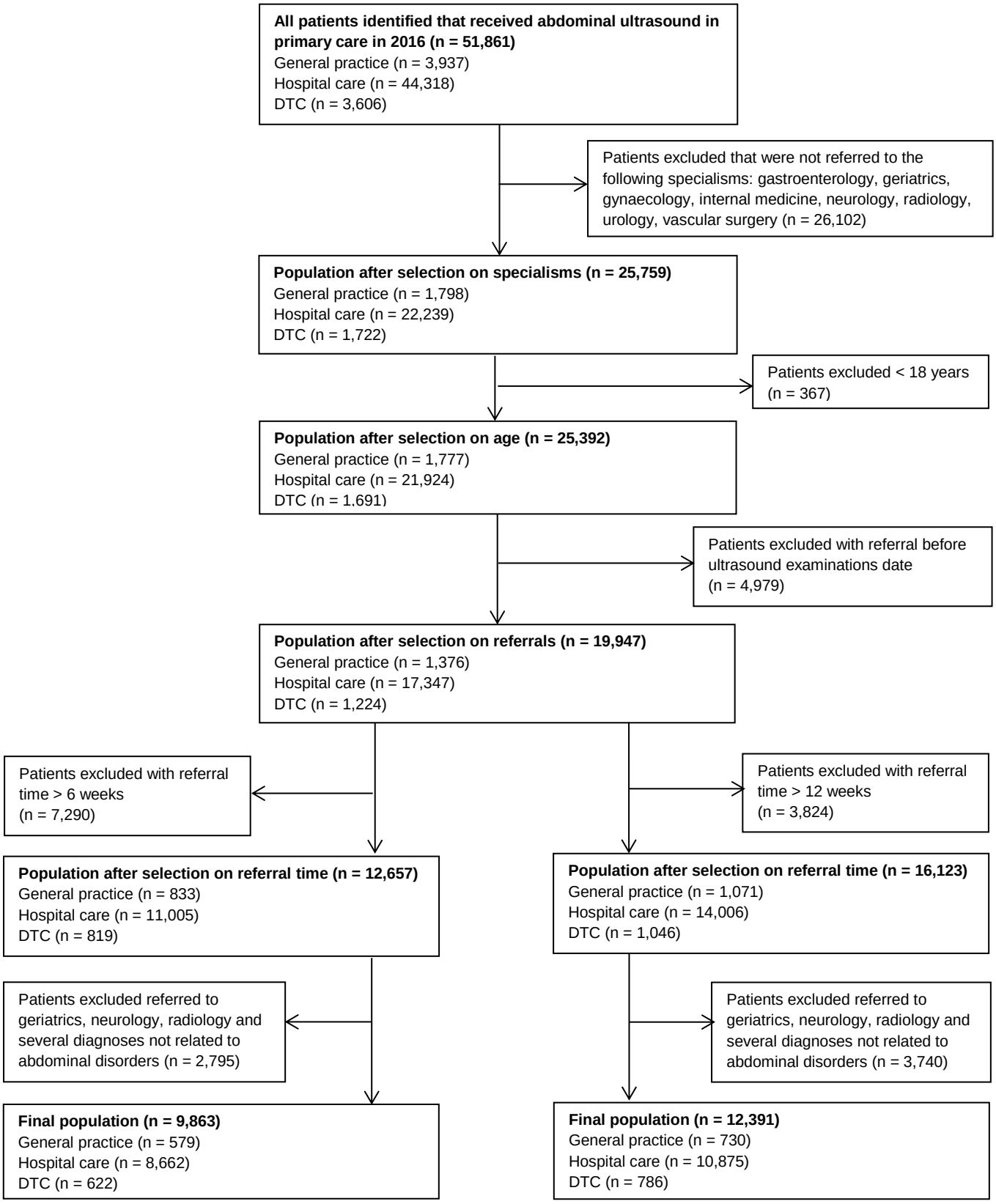

Figure 1. Flowchart regarding selection of patients. This figure shows the steps taken in the data selection from the initial population of patients to the population the analysis was conducted on, outlined per scenario.

Scenarios

The number of referrals from primary care to specialist care were compared for three scenarios: abdominal ultrasound in general practice, hospital and DTCs (Figure 2). All scenarios comprise patients with abdominal pain. In the general practice-scenario, abdominal ultrasound is performed by a GP, after which the medical findings can be shared with the patient immediately combined with information about a possible referral to specialist care. In the hospital care-scenario, which is used most frequently, abdominal ultrasound is requested by a GP and carried out by a radiologist or laboratory assistant supervised by a radiologist. After the ultrasound examination, the medical findings are sent back to the GP upon which a medical diagnosis and possible referral decision can be made. The same applies for the DTC-scenario, except in this case the abdominal ultrasound takes place in diagnostic treatment centres. Face validity of the analysis was obtained by validating the chosen time horizon, target population, scenarios and costs with decision makers of a health insurer.

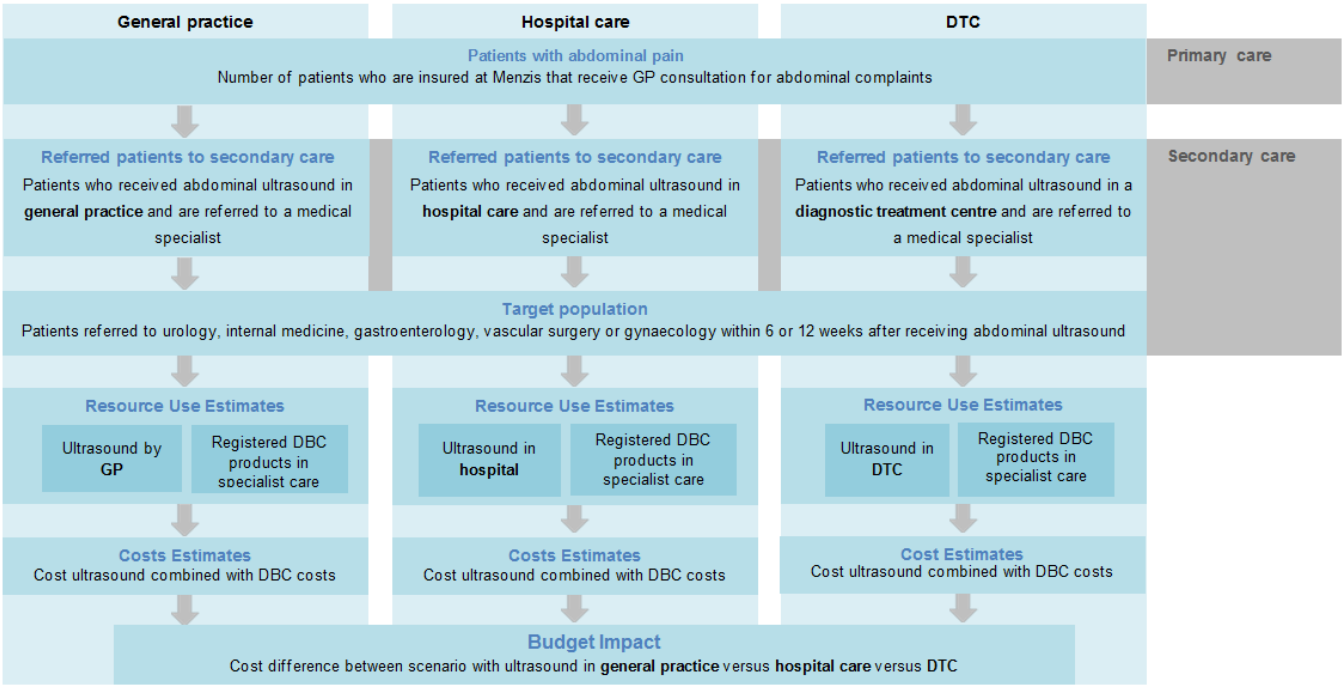

Figure 2. Budget impact scheme (adapted from Brosa et al. 2005 (28)). This figure shows the analytical framework used in this study to perform the budget impact analysis as well as the scenarios to be compared.

Sensitivity analysis

Since much of the parameter uncertainty in BIAs cannot be meaningfully quantified, standard approaches used to investigate the uncertainty in cost-effectiveness analyses, like one-way and probabilistic sensitivity analysis, cannot be carried out fully (23,25). For this reason, scenario analyses were undertaken in which alternate scenarios as compared to the considered ultrasound procedures in primary care were taken into account. Specifically, the impact of performing ultrasound examinations at so called primary care plus facilities (i.e. facilities in which hospital care is substituted to primary care (34)) on healthcare costs was calculated. The tariff and clinical indications for ultrasound examinations in general practice were split into two categories: one tariff for goal-directed, low-complex ultrasound examinations (target ultrasound, €30) which can still be performed by a GP, and a different tariff for moderate to high-complex ultrasound examinations (triage ultrasound, €70) which is performed by a radiologist or laboratory assistant (supervised by a radiologist) in primary care plus facilities. As the second category includes involvement of a medical specialist, this tariff is higher compared with the low-complex ultrasound in which no medical specialist is involved. Since no evidence about the distribution of target and triage ultrasound in practice could be found, three scenarios were drafted in which the effect of the divided tariff for ultrasound examinations in general practice was estimated; 1) a scenario consisting of 25% target ultrasound and 75% triage ultrasound,

2) a scenario including 50% target ultrasound and 50% triage ultrasound, and 3) a scenario containing 75% target ultrasound and 25% triage ultrasound. In all scenarios, the number of ultrasound examinations in hospital care and DTCs would decline as all scenarios involve a (partly) substitution of ultrasound examinations from secondary to primary care. A recent pilot in which two hospitals substituted ultrasound to primary care plus facilities was used to calculate the decline of ultrasounds in hospital care and DTCs. In this pilot, the hospitals stated that 15% of the total amount of ultrasound examinations could be moved to primary care plus facilities. Therefore, it was assumed that 15% of the abdominal ultrasounds performed in hospital care and DTCs could be substituted to primary care plus accommodations. Further, since the tariffs for ultrasound examinations used strongly differ compared to the national tariffs of the NZa, another scenario was drafted in which the impact of using NZa tariffs was evaluated. These results can be found in Appendix 4.

Interviews

To interpret the results of the BIA, qualitative semi-structured interviews containing 17 questions were performed with GPs (n = 4) and radiologists (n = 7). The aim of these interviews was to identify their opinions with regard to the performance of ultrasound examinations by GPs. The first part of this questionnaire (two questions) included general information about the GP or radiologist (e.g. years of work experience, type of sub specialism of the radiologist). The second element (three questions) concerned characteristics of the patient population, including estimated numbers of how many ultrasounds were performed by GPs or radiologists on daily basis and how many of them were abdominal ultrasounds. The third element involved the execution and interpretation of the ultrasound. The exact (number of) questions that were posed depended on whether the GP usually performs ultrasounds themselves (seven questions), or whether the GP sends these patients to a hospital or DTC (four questions). The radiologist was posed the same questions as the GPs who performed ultrasound themselves. Questions asked in this section were related to incentives for performing or ordering the ultrasound, procedure of the ultrasound examination, reporting of the result, archiving of the taken images, further patient management after the ultrasound examination, ultrasound training and ultrasound equipment. The fourth element (four questions) involved questions about reimbursement of the ultrasound, the general opinion of the GP or radiologist regarding the performance of ultrasound examinations by GPs and if this would lead to fewer referrals to specialist care and finally the preconditions of performing abdominal ultrasound in general practice. The fifth element contained one question to complete the interview, namely: “Is there anything that was not discussed during this interview, but it is important to mention? If yes, please feel free to bring up this subject.” The full questionnaire (translated to English) is provided in Appendix 5.

Prior to the interview, all GPs and radiologists were informed about the objective of the study and about the way the obtained answers would be processed. In addition, written consent for usage of the results was obtained. All interviews were audio-recorded and carried out by one researcher. Representativeness of the responding GPs and radiologists in the Netherlands was achieved by approaching Dutch general practices and hospitals that serve patient populations which differ with regard to population size and geographical characteristics. All interviews were transcribed verbatim and processed anonymously. Furthermore, all participants were approached for a member check (35) and given possibility to comment or object on the transcript. The transcripts were analysed in Atlas.ti (version 8.2.3). Inductive coding was used to yield more valid results and to identify linkages between the results of the interviews (36). First, open coding was applied after which a total of 19 coding categories were defined. Second, axial coding was used after which five coding categories were excluded. Third, selective coding was applied in order to elaborate the final coding categories and coherence between the different codes. This led to the final inclusion of eleven coding categories.

Results

Distributed over 220 general practices and 7 health centres, 4,297 abdominal ultrasounds were performed among 3,827 patients (mean = 1.1, SD = 0.5). In contrast, distributed over 79 hospitals, 44,717 abdominal ultrasounds were performed among 43,002 patients (mean = 1.1, SD = 0.2). Within 19 DTCs, 4,248 ultrasounds were performed among 3,503 patients (mean = 1.2, SD = 0.8). A detailed overview of the results for each evaluated scenario is presented in Table 3.

The results indicate that referral rates within six weeks for patients receiving abdominal ultrasound in general practice are 5.0% lower as compared to hospital care (15.1% vs 20.1%) and 2.7% lower as compared to DTCs (15.1% vs 17.8%). Considering twelve-week referral rates, patients receiving abdominal ultrasound in general practice are less often referred as well (19.1% vs 25.3% and 22.4%). A difference in mean ultrasound costs per patient was found between the three scenarios (€68 vs €93 and €98), which is mainly attributable to the use of different reimbursement tariffs for ultrasound examinations mentioned in Table 2. However, comparing hospitals and DTCs, a mean difference of €5 per patient is found while the same reimbursement tariff is normally used for these two types care providers. Looking at the different age categories, especially lower treatment costs are found for patients from younger age categories (18-34 and 35-49 years of age). Mean treatment costs for patients referred within six weeks were found lowest for patients from DTCs (€1,543 vs €1,593 in general practice and €1,666 in hospital care), whereas the lowest treatment costs for patients referred within twelve weeks are seen for patients from general practice (€1,427 vs €1,431 in DTCs and €1,563 in hospital care). Overall, the highest treatment costs per patient are seen for patients above 50 years of age.

Considering referral rates to specific medical specialities, a summary including the top four diagnoses per medical specialty is provided for each scenario in Table 4. Patients receiving ultrasound in general practice are mostly referred to gynaecology (20.7%), whereas patients receiving ultrasound in hospital care or DTCs are mostly referred to vascular surgery (25.9% and 25.7%). Furthermore, the most common diagnoses per medical specialty are nearly equal for each scenario, although different in ranking and prevalence.

Scenario analysis

The results indicate that a mean cost reduction of €8 per patient per ultrasound (25/75 scenario) can be achieved for patients receiving ultrasound in general practice, which can increase up to €28 per patient per ultrasound (75/25 scenario), if the ultrasound tariff for general practice would be divided into target and triage ultrasound. Considering the ultrasound costs in hospital care and DTCs, cost savings can be realized as well (€12 in hospital care vs €18 in DTCs). An overall cost reduction of €494,550 (25/75 scenario) can be achieved for primary care if cost savings for general practice, hospital care and DTCs would be combined. Subsequent, a cost reduction of €537,030 (50/50 scenario) or €624,550 (75/25 scenario) could be achieved if the other scenarios would be applied. An overview of the outcomes per scenario is shown in Table 5 and 6.

Table 3. Referrals from primary to specialist care with corresponding healthcare costs

Parameters	General practice			Hospital care			Diagnostic treatment centre		
	n (%)	Mean costs per patient (€, 95% CI)	Total costs (€)	n (%)	Mean costs per patient (€, 95% CI)	Total costs (€)	n (%)	Mean costs per patient (€, 95% CI)	Total costs (€)
Number of patients with abdominal ultrasound									
Total population [*n(%)]*	3,827 (100.0)	68 (67 to 69)	267,737	43,002 (100.0)	93 (93 to 94)	3,715,252	3,503 (100.0)	98 (95 to 100)	338,068
Male [*n(%)]*	1,114 (29.1)			14,326 (33.3)			1,290 (36.8)		
Age									
18-34	949 (24.8)	69 (68 to 71)	65,688	7,635 (17.8)	93 (91 to 94)	653,373	785 (22.4)	85 (83 to 87)	67,230
35-49	972 (25.4)	70 (68 to 73)	68,464	10,483 (24.4)	93 (92 to 94)	905,741	891 (25.4)	91 (88 to 94)	80,349
50-64	946 (24.7)	68 (66 to 69)	64,052	12,992 (30.2)	93 (92 to 95)	1,124,70	1,060 (30.3)	99 (94 to 103)	104,099
65-79	759 (19.8)	65 (64 to 67)	49,383	9,461 (22.0)	94 (93 to 96)	823,253	652 (18.6)	113 (105 to 121)	73,566
≥ 80	201 (5.3)	65 (62 to 68)	13,150	2,431 (5.7)	91 (89 to 93)	208,716	115 (3.3)	112 (96 to 127)	12,824
Referrals to specialist care within 6 weeks									
Total population [*n(%)]*	579 (15.1)	1,593 (1,383 to 1,803)	1,086,343	8,662 (20.1)	1,666 (1,618 to 1,714)	17,190,258	622 (17.8)	1,543 (1,374 to 1,712)	1,138,442
Male [*n(%)]*	194 (33.5)			3,238 (37.4)			254 (40.8)		
Age									
18-34	89 (15.4)	1,331 (995 to 1,667)	133,057	1,110 (12.8)	1,478 (1,378 to 1,576)	1,829,236	91 (14.6)	1,110 (771 to 1,449)	118,769
35-49	121 (20.9)	1,261 (1,003 to 1,520)	182,871	1,869 (21.6)	1,556 (1,468 to 1,644)	3,348,830	157 (25.2)	1,234 (1,001 to 1,467)	220,912
50-64	172 (29.7)	1,855 (1,340 to 2,369)	376,514	2,683 (31.0)	1,671 (1,590 to 1,752)	5,292,559	210 (33.8)	1,606 (1,298 to 1,913)	396,598
65-79	160 (27.6)	1,738 (1,312 to 2,163)	330,184	2,416 (27.9)	1,789 (1,680 to 1,897)	5,394,455	129 (20.7)	2,078 (1,590 to 2,566)	326,278
≥ 80	37 (6.4)	1,448 (870 to 2,026)	63,718	584 (6.7)	1,779 (1,584 to 1,974)	1,325,177	35 (5.6)	1,581 (999 to 2,162)	75,885
Referrals to specialist care within 12 weeks									
Total population [*n(%)]*	730 (19.1)	1,427 (1,264 to 1,589)	1,341,138	10,875 (25.3)	1,563 (1,522 to 1,604)	22,488,293	786 (22.4)	1,431 (1,295 to 1,567)	1,494,041
Male [*n(%)]*	236 (32.3)			4,020 (37.0)			315 (40.1)		
Age									
18-34	121 (16.6)	1,089 (834 to 1,345)	149,225	1,408 (12.9)	1,322 (1,241 to 1,403)	2,232,579	122 (15.5)	1,071 (792 to 1,349)	161,650
35-49	158 (21.6)	1,094 (903 to 1,286)	230,919	2,328 (21.4)	1,466 (1,387 to 1,545)	4,300,811	200 (25.4)	1,150 (957 to 1,343)	279,443
50-64	205 (28.1)	1,635 (1,240 to 2,030)	446,325	3,410 (31.4)	1,561 (1,492 to 1,631)	7,052,252	257 (32.7)	1,493 (1,248 to 1,738)	524,028
65-79	192 (26.3)	1,607 (1,270 to 1,944)	417,804	3,015 (27.7)	1,702 (1,610 to 1,793)	7,215,241	168 (21.4)	1,789 (1,429 to 2,149)	429,352
≥ 80	46 (6.3)	1,642 (1,051 to 2,233)	96,865	714 (6.6)	1,674 (1,514 to 1,834)	1,687,410	39 (5.0)	1,688 (1,093 to 2,283)	99,568

In this table, an overview of the performed ultrasounds in general practice, hospital care and DTCs is given as well as the resulting referral rates and costs for the total population, gender and age. A 95% CI was given for the mean costs of the ultrasound examinations and DBC products in specialist care.

Table 4. Most frequently registered diagnoses per specialism

General Practice		Frequency (%)	*Hospital care*	Frequency (%)	*DTC*	Frequency (%)
Total *[n (%)]*		**940 (100.0)**		**14,388 (100.0)**		**1,044 (100.0)**
Gastro-intestinal disorders		**188 (20.0)**		**3,119 (21.7)**		**218 (20.9)**
Ranking						
1	Diverticulitis	24	Diverticulitis	467	Diverticulitis	34
2	Cholelithiasis	21	Chronic abdominal pain	317	Functional dyspepsia	22
3	Chronic abdominal pain	18	Functional dyspepsia	242	Hepatitis	19
4	Functional dyspepsia	17	Cholelithiasis	180	Chronic abdominal pain	18
Gynaecology		**195 (20.7)**		**1,732 (12.0)**		**135 (12.9)**
Ranking						
1	Cycle disorder (benign, including vaginal blood loss)	56	Cycle disorder (benign, including vaginal blood loss)	332	Benign adnexa abnormalities	35
					Cycle disorder (benign, including vaginal blood loss)	18
2	Benign adnexa abnormalities	34	Benign adnexa abnormalities	326		
3	Abdominal pain without gynaecological cause	22	Abdominal pain without gynaecological cause	246	Uterus myomatosus	15
4	Cervix abnormalities	14	Uterus myomatosus	133	Ovary malignancies	11
Internal medicine		**175 (18.6)**		**3,279 (22.8)**		**215 (20.6)**
Ranking						
1	Abdominal pain without diagnosis	33	Analysis abdominal pain without diagnosis	617	Abdominal pain without diagnosis	33
2	Colorectal malignancies	17	Colorectal malignancies	195	Colorectal malignancies	19
3	Analysis without diagnosis	14	Analysis without diagnosis	175	Malaise	12
4	Chronic kidney insufficiency	6	Chronic kidney insufficiency	149	Analysis abdominal pain without diagnosis	11
Vascular surgery		**197 (20.1)**		**3,725 (25.9)**		**268 (25.7)**
Ranking						
1	Cholecystitis	96	Cholecystitis	1689	Cholecystitis	102
2	Undefined abdominal symptoms	23	Femoral hernia	411	Femoral hernia	47
3	Femoral hernia	17	Undefined abdominal pain	335	Undefined abdominal symptoms	35
4	Aneurysm iliac artery	12	Umbilical hernia	242	Umbilical hernia	18
Urology		**185 (19.7)**		**2,533 (17.6)**		**208 (19.9)**
Ranking						
1	Prostate BPH obstruction	33	Kidney stones	425	Kidney stones	47
2	Bladder infection	20	Ureter stones	367	Ureter stones	34
3	Ureter stones	20	Prostate BPH obstruction	259	Bladder tumour	25
4	Prostate carcinoma	15	Bladder infection	242	Prostate BPH obstruction	25

In this table, the most common diagnoses per medical specialty are given as well as their prevalence rates.

Table 5. Scenario analysis for general practice

	Costs current situation	Costs new situation	Mean costs per patient (95% CI)	Cost reduction
25/75 scenario	€260,737	€257,390	€60.0 (€59.4 to €60.5)	€3,347
50/50 scenario	€260,737	€214,910	€50.1 (€49.5 to €50.7)	€45,827
75/25 scenario	€260,737	€127,390	€40.2 (€39.7 to €40.7)	€133,347

This table provides insight in the cost reduction when two different tariffs for the ultrasound examinations in general practice would be applied.

Table 6. Scenario analysis hospital care and DTCs

	Costs current situation	Costs new situation	Mean costs per patient (95% CI)	Cost reduction
Hospital	€3,715,252	€3,231,399	€81.3 (€81.2 to €81.4)	€483,853
DTC	€347,954	€340,604	€80.2 (€79.9 to €80.4)	€7,350

This table provides insight in the cost reduction when part (6.9%) of the ultrasound examinations performed in hospital care and DTCs would be shifted to primary care plus.

Preconditions for ultrasound in general practice according to GPs and radiologists

Characteristics of participating GPs and radiologists

In total, four GPs and seven radiologists participated in the interviews. Results of two GPs and one radiologist could only be used partially, since one GP returned an individually written survey and the audio-recording of another GP could not be used due to bad quality of the audio-recording. The concerning radiologist only gave permission to start the audio-recording from half-way of the interview onwards, upon which only notes from the first half of the interview were allowed to be used. These results were not excluded, since the notes taken during the interviews also provided valuable insights.

Of the four participating GPs, two were male, the average working experience was 14.2 years (SD = 12.3) and all GPs were working at different general practices, of which two GPs had their own practice. Three GPs were qualified to perform ultrasound examinations, one GP had also been working in the field of tropical medicine and one GP was specialized in medical conditions related to urology and gynaecology. Of the seven participating radiologists, all were male, the average working experience was 14.6 years (SD = 11.2) and in total, radiologists from five different hospitals were interviewed (three radiologists were working at the same hospital). Four radiologists were specialised in abdominal radiology, two radiologists in musculoskeletal radiology and one radiologist in neuroradiology.

Turnover of ultrasound examinations in general practice and hospital care

Of the GPs that perform ultrasound examinations in general practice, two GPs indicated to perform ~2 ultrasounds per week and one GP indicated to perform ~2-5 ultrasounds per week. Radiologists estimate that, in a regular ultrasound program comprising 4 hours in hospital care, approximately 20-25 ultrasounds are performed. More than half of those ultrasounds are dedicated to abdominal pathology. Both GPs and radiologists emphasize that, in general, the prevalence of pathology is very low (estimates are 4%-5%) in the population of patients presenting with abdominal pain in primary care

Ultrasound procedure, reimbursement and preconditions

All GPs highlighted that, besides the medical indications of the M&I service (Table 1), abdominal ultrasound is often indicated as reassurance to patients. Only if there is high suspicion of severe pathology, patients would be sent to a hospital or DTC for the ultrasound. In case the ultrasound was performed in general practice, patients received the result immediately combined with the referral decision of the GP – if relevant. Two GPs used point-of-care equipment and one GP used portable

high-end equipment to perform the ultrasounds. The results were reported in an Electronic Health Record (EHR) and the images taken during the examination were stored on the ultrasound device itself or on a flash drive/USB stick. The GP that did not perform ultrasound in general practice indicated that guidelines of the Dutch College of General Practitioners were followed to decide if ultrasound in a hospital or DTC was necessary. If so, the patient was send to a hospital or DTC after which the report of the radiologist concerning the findings of the imaging examination were send via a secured connection to the GP. After this, a patient was informed by telephone, e-mail or during a subsequent consultation about further treatment. Considering the reimbursement of ultrasound examinations, all GPs confirmed to use the M&I service.

Five radiologists performed ultrasound examinations in hospital care as well as in primary care plus whereas two radiologists only performed ultrasound examinations in hospital care. One radiologist was involved in hospital care as well as in a DTC. All ultrasound examinations were performed on request of the GP. According to radiologists, the main difference between hospital care and primary care plus settings are facilities (such as a proper darkened room), equipment and reporting possibilities. High-end equipment was used in all hospitals compared to portable or point-of-care equipment in primary care plus settings. In hospital care, the result of the ultrasound examination was reported in the concerning EHR, in which the taken images during the examination were also stored. In this way, archiving is being taken care of. Reimbursement of the ultrasound examination by radiologists is always declared via the product “Examination of abdominal organs through ultrasound” as mentioned in Table 2.

Three out of four GPs emphasized that performing ultrasound examinations in general practice would lead to fewer referrals. All radiologists stated the contrary. In addition, five out of seven radiologists highlighted that ultrasound examinations performed by GPs are often repeated in specialist care, since medical specialists do not want to rely on GPs ultrasound findings. Furthermore, all participants except for one GP mentioned that diagnostic and triage ultrasound is part of the field of a radiologist, given the amount of education, training and daily turnover of patients with high pathology they are exposed to in hospital care. Four out of seven radiologists stated that a difference between target and triage ultrasound could be made for performing ultrasound in general practice. Target ultrasound would entail a very specific and narrow examination, whereas triage ultrasound would require a broad diagnostic examination. Three out of four GPs and four out of seven radiologists stated that target ultrasound examinations are suitable for general practice. Triage ultrasound, in contrast, would be part of the field of a radiologist and should therefore not be performed in general practice, unless a radiologist would be involved as for example in primary care plus facilities. For this construction, six out of seven radiologists stated that fewer referrals to specialist care could be accomplished, since a high skilled medical specialist would then be involved and a learning effect for GPs in clinical indications for requesting ultrasound examinations could be achieved. Further preconditions mentioned by GPs and radiologists to perform ultrasound in general practice concerning the procedure of the ultrasound, use of equipment and logistics, can be found in Table 7.

Table 7. Preconditions mentioned by GPs and radiologists to perform ultrasound examinations in general practice

	GP 1	GP 2	GP 3	GP 4	R1	R2	R3	R4	R5	R6	R7
Procedure ultrasound											
Archiving of images and report	x		x	x		x	x	x	x	x	x
Complication register								x	x		
Other imaging techniques as comparison								x	x		
Peer-to-peer coaching			x	x					x		
Reporting in EHR			x	x		x	x	x	x	x	x
Supervision/continuous feedback			x			x		x	x		x
Equipment											
Live connection with radiologist	x				x	x		x	x	x	
Point-of-care equipment	x		x	x	x	x			x	x	x
Understanding of technical limitations equipment							x	x			
Logistics											
Availability of medical history			x	x	x	x	x	x	x	x	
Collaboration between GP and medical specialist	x		x	x		x		x		x	x
High utilization of consultation hours	x			x	x	x	x			x	x
Secondary conditions*				x			x	x		x	x

This table shows the main findings of the interviews with GPs and radiologists, showing the preconditions for performing ultrasound examinations by a GP in general practice. *I.e. dedicated and proper darkened room for ultrasound examinations, appropriate cleaning possibilities for equipment**.** *EHR* Electronic Health Record, *GP* general practitioner, *R* radiologist.

Discussion

In this study, the results of the BIA indicate that abdominal ultrasound in general practice leads to lower referrals to specialist care as compared with abdominal ultrasound in hospital care and DTCs. In addition, results indicate that abdominal ultrasound in general practice leads to lower ultrasound costs and lower average treatment costs for patients referred within twelve weeks to specialist care. For this reason, offering abdominal ultrasound in general practice seems a good alternative to prevent referrals to specialist care and reduce healthcare spending. Furthermore, the scenario analysis shows that splitting the reimbursement tariff for ultrasound examinations in general practice reduces ultrasound costs, regardless of scenario choice (i.e. 25/75 scenario, 50/50 scenario, 75/25 scenario). As almost all GPs and radiologists support the idea of splitting the tariff for ultrasound in general practice, the possibility of performing ultrasound examinations by radiologists in primary care plus facilities raises as a potential model of care.

Findings in relation to other studies

This study is, to the best of our knowledge, the first to specifically investigate the transition of abdominal ultrasound from hospital care to general practice by evaluating its effect on hospital referrals and healthcare costs from the perspective of a health insurance company. However, Bhagra *et al.*, (2016) investigated ultrasound request behavior of GPs as well as the frequency of ultrasound findings. 28.8% of the total amount of performed ultrasound examinations showed clinical abnormalities, in which a prevalence of 6.6% for cholecystitis and 2.3% for kidney stones was found (8). These findings are in line with our findings, since cholecystitis and kidney stones were the most common diagnoses for vascular surgery and urology in this study. Wordsworth and Scott (2002) carried out a cost analysis in which ultrasounds performed in general practice and hospital care were compared. They found that ultrasound examinations in general practice led to a reduction in healthcare costs due to a decrease in hospital referrals and prevention of consultation costs of medical specialists (17), which is consistent with the findings in our study.

Strengths and limitations

A strength of this study is the use of data from a large patient population, which improves generalizability of the results. However, the current analysis has a number of limitations that need to be considered. In this study, data about the performed ultrasound examinations was limited to reimbursement claims. Whilst the financial incentive makes it likely that almost all of the performed examinations eligible for reimbursement were registered, non-eligible examinations such as ultrasounds performed during regular consultations hours or ultrasounds registered as “undefined” in innovative care projects could not be quantified and were therefore not included in the analysis. For this reason, the amount of performed ultrasound examinations might be underestimated. Besides that, no data about the clinical findings during the ultrasound examination or medical incentives for referring patients to specialist care were available. For this reason, it cannot be confirmed with absolute certainty that the identified referrals are a consequence of the ultrasound examination, even though an attempt was made to increase this chance by only including patients that were referred within six or twelve weeks to medical specialties that specifically treat abdominal disorders. In addition, due to the lack of data about the clinical findings, the influence of false-positive and false-negative outcomes of the abdominal ultrasound on the (accompanying) number of referrals could also not be assessed. Besides this, the impact of point-of-care equipment versus high-end equipment on diagnostic accuracy, health outcomes and costs not been included in this study and could therefore not be investigated. Another limitation of this study concerns the discouragement of the Dutch National Healthcare Institute to use DBC products in economic evaluations. In order to establish DBC tariffs, patients are classified to more or less homogenous groups in terms of medical conditions and treatments (27). The spread of the mean costs between different DBC products can therefore be substantial, which makes the calculated expenses in specialist care less accurate. However, since reimbursement of specialist care in the Netherlands is solely carried out via the DBC system, using DBC products provided the most representative results for the considered scenarios. Furthermore, as

this study specifically focused on abdominal ultrasound examinations, these results might not be generalizable to other types of ultrasound examinations that are often performed in primary care (i.e. musculoskeletal ultrasound, breast ultrasound, scrotum ultrasound). In addition, this study was conducted on declaration data of a single health insurer in the Netherlands. Considering generalizability of the results to other health insurers in the Netherlands, the extent to which this is possible is unknown as no data about population characteristics of those health insurance companies was (publicly) available at the time the study was performed. Another limitation relates to the limited number of respondents with regard to the interviews. Although consistency between answers of radiologists was high, results obtained from GPs differed a lot and were hard to compare due to the inoperable audio-recording and written answers of two GPs. For this reason, more semi-structured interviews with GPs should have been performed in order to work towards theoretical saturation (37).

Implications for practice

Previous studies have shown that factors contributing to the rise in volume of imaging services in primary care as well as in secondary care are availability and accessibility together with the improvement in quality of imaging techniques (38,39). The concern however rises that supply might exceed its actual demand (40). During the interviews, almost all radiologists emphasized that ultrasound examinations performed by GPs in primary care are mostly repeated in specialist care, since medical specialists do not want to rely on GPs ultrasound findings due to the low numbers of ultrasounds they perform in general practice. The costs savings that can be achieved by providing ultrasound in general practice are then undermined. Further research is necessary to investigate the impact of ultrasound examinations in general practice on over-treatment due to benign incidental findings and repeated diagnostic ultrasounds. Besides that, as DBC products are actually case-mix based tariffs for the entire treatment of a patient, these DBCs already contain costs for additional imaging examinations. This leads to cumulative expenses and complicates the calculation of cost saving potentials. Further research is needed into the impact on costs of repetitive ultrasound in secondary care. Furthermore, a lot of differences in reimbursement tariffs for ultrasound examinations were seen (e.g. €40 to €75 versus €56 as set tariff in general practice). Apparently, there must be indications for contracting different ultrasound prices. However, in order to steer on equal reimbursement tariffs between care providers, adequate monitoring of contracted ultrasound tariffs during the purchasing process is recommended. Furthermore, this study revealed that savings in ultrasound costs and treatment costs are more likely for younger age categories (18-34 and 35-49 years of age). Despite the fact that little information is known about population characteristics of other health insurance companies in the Netherlands, similar costs reductions might be expected if the concerning patient population comprises comparable age characteristics.

Implications for further research

Early research focused on the differences in ultrasound findings between GPs (who have had sufficient ultrasound training) and radiologists (12,13). However, none of these studies estimated diagnostic validity in terms of sensitivity and specificity. Moreover, although it was assumed that health outcomes were equal between the different scenarios in primary care, actual CEAs about performing abdominal ultrasound in general practice versus hospital care were not found in literature. Since this study only focused on the financial impact of abdominal ultrasound in primary care, diagnostic accuracy of GPs performing ultrasound examinations or other health benefits for patients (e.g. quality-adjusted life years, morbidity and mortality) were not included. It is therefore recommended to perform a CEA into this subject, investigating the impact of differences in diagnostic accuracy between GPs and radiologists on referral management as well as on the accompanying costs. Consequently, a CEA would provide more insight into the cost impact of abdominal ultrasound in general practice from a societal perspective. With regard to the fact that this study specifically focused on abdominal ultrasound, additional research is necessary to evaluate the cost impact for other types of ultrasound in primary care. Furthermore, GPs and radiologists state that the prevalence of abdominal pathology in primary care is low. This, in combination with the low rate of performed

ultrasounds by a GP in general practice, results in the fact that GPs are not able to retain their ultrasound skills after completing the ultrasound training. Further studies are needed to evaluate the level of training and required turnover to maintain sufficient skill level after completing the ultrasound training. In addition, if GPs could retain their ultrasound skills on a high level, this might result in less repetitive ultrasound examinations in secondary care as well as strengthening of their gatekeeping role in the Dutch healthcare system.

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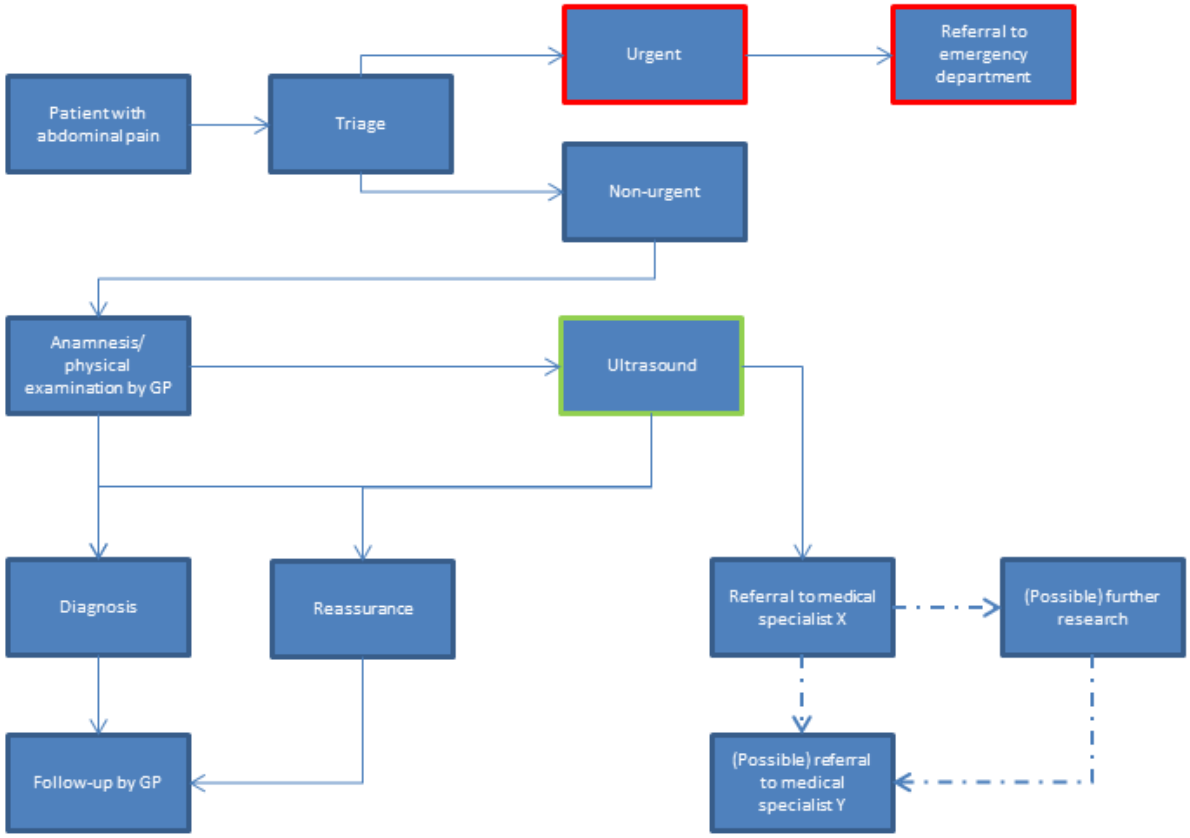
Appendix 1: Pathway of patients with abdominal pain with diagnostic ultrasound



Legend:

Urgent path: direct refferal to secondary care, excluded in this study

Different scenario's possible concerning the performance of ultraound (for example: general practice, hospital care and diagostic treatment centre)

Appendix 2: Number of referrals to specialist care

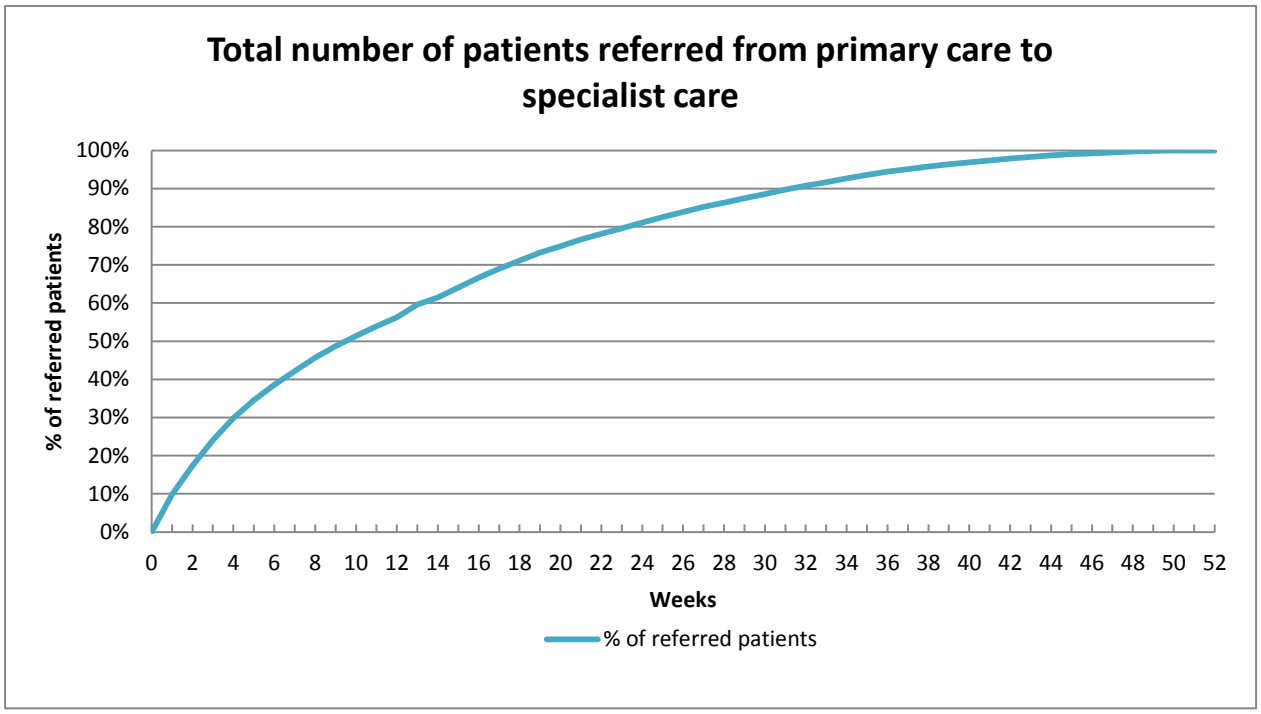


Figure 3. Total number of referred patients from primary care to specialist care per week. This figure shows the percentage of all patients referred from general practice, hospital care and DTCs to specialist care over time.

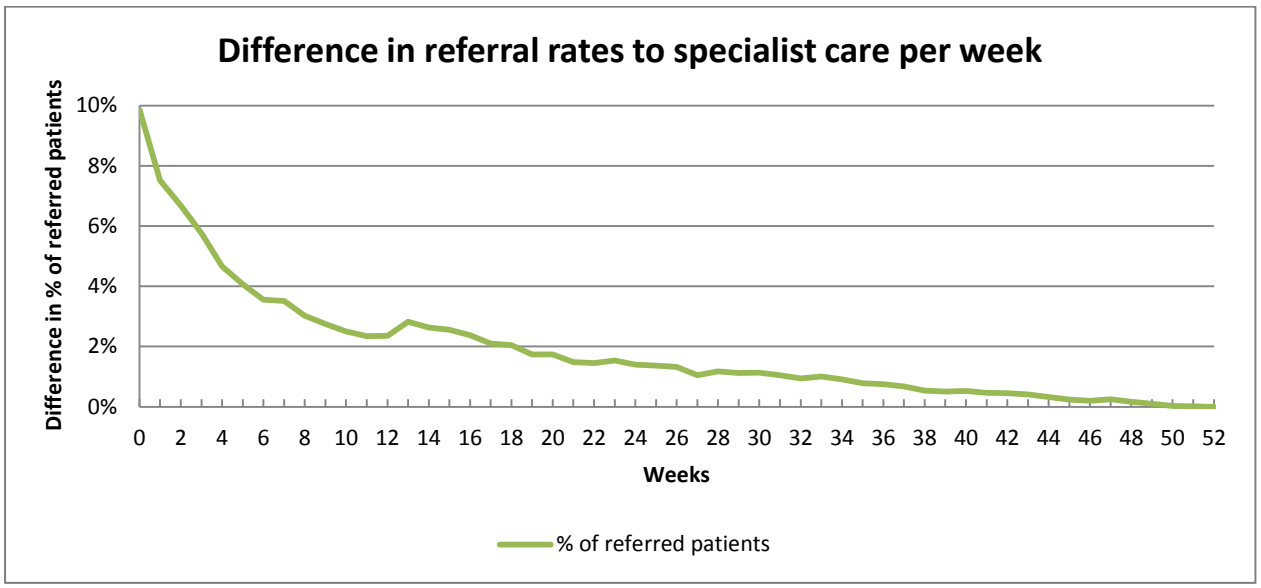


Figure 4. Difference in referral rates for patients from primary care to specialist care per week. This figure shows the differences in referrals rates for all patients referred from general practice, hospital care and DTCs to specialist care over time.

Appendix 3: Excluded medical specialties

Table 8. Overview of excluded medical specialties

Medical specialty		
Anaesthesiology	Genetics	Ophthalmology
Audiology	Geriatrics	Orthopaedics
Cardiology	Otorhinolaryngology	Plastic surgery
Cardiopulmonary surgery	Pulmonary medicine	Psychiatry
Dermatology	Neurosurgery	Radiology
Paediatrics	Neurology	Radiotherapy

This table gives an overview of all medical specialties that were excluded in the first selection step.

Table 9. Overview of excluded subspecialties

Medical specialty	**Subspecialty**
Gastroenterology	Oesophagus
Gynaecology	Obstetrics and labour Infertility Contraception
Internal medicine	Allergology Systematic diseases Haematology
Urology	Testis and scrotum Penis and genitals
Vascular surgery	General paediatric surgery Upper extremities Lower extremities Head and neck surgery Traumatology and emergency medicine Thoracic surgery

This table gives a rough overview of the excluded subspecialties per medical specialty that were included in the analysis, since these focus areas did not contain abdominal disorders or other pathology related to abdominal symptoms.

Appendix 4: Scenario analysis for NZa tariffs

Table 10. Scenario analysis for NZa tariffs

	Costs current situation	NZa prices	Costs new situation	Cost differences
General practice	€260,737	€39,93	€171,579	-€171,319
Hospital care	€3,715,252	€85.28	€3,837,685	+€122,433
DTC	€347,954	€85.28	€352,206	+ €4,252

This table provides insight into the cost differences when tariffs of the NZa (9) would be used for reimbursement of ultrasound examinations in general practice, hospital care and DTCs.

Appendix 5: Interview schedule

Dear general practitioner/radiologist,

Thank you for participating in this study. Your answers contribute to the establishment of a quality framework relating to the performance of diagnostic ultrasound in general practice, specifically abdominal ultrasound. This interview contains several questions regarding the prevalence of abdominal ultrasound in primary care, the execution and interpretation of the ultrasound and the ultrasound training of general practitioners. Furthermore, questions about the preconditions for ultrasound examinations in general practice will be asked.

The interview will last approximately 30-45 minutes and the answers will be processed anonymously. Prior to the interview, an information letter was provided in which the objective, duration of the study, duration of the interview as well as information about how the obtained answers will be processed was given.

Questions prior to the interview:

Are there any questions or remarks in response to the information letter?	Yes/No
Do you give permission for audio-recording this interview?	Yes/No
Have you signed the informed consent letter? If no, why not?	Yes/No
Do you want to receive the transcribed interview and participate in a member check?	Yes/No
Do you want to receive a copy of the final article?	Yes/No

Specific question for general practitioners:

Do you perform ultrasound examinations in general practice yourself?

No > execution and interpretation of the ultrasound – category A

Yes > execution and interpretation of the ultrasound – category B

Topic list – interview
General information about GP/radiologist
1. For how many years are you working as a GP/radiologist?
2. To radiologist: what is your type of sub specialism?
Characteristics of the patient population
3. Can you give an estimation of how many patients you see on annual base?
4. How many ultrasound examinations do you perform on daily basis?
5. How many of those include *abdominal* ultrasound examinations?

Execution and interpretation of the ultrasound – *category A*
6. What medical indications or possible other incentives are underlying to the request of an ultrasound examination in a referral hospital/diagnostic treatment centre?
7. Could you give a description of how the medical findings of the ultrasound examination are received?
8. Could you give a description of the further patient management after receiving the medical findings of the ultrasound?
9. If patients with abdominal pain are referred to a medical specialist due to medical findings during the ultrasound examination, to what medical specialists are they mostly referred?
Execution and interpretation of the ultrasound – *category B*
6. What medical indications or possible other incentives are underlying to the execution of an ultrasound examination?
7. Could you give a description of the procedure of the ultrasound examination?
8. Could you give a description of how the medical findings are noted?
9. Could you give a description of the archiving process of the taken images during the ultrasound examination?
10. Could you give a description of the further patient management after receiving the result of the ultrasound?
11. Can you tell something about the ultrasound training you followed?
12. Can you tell something about the ultrasound equipment that is used for performing the ultrasound examinations?
Reimbursement and ultrasound training
13. Could you give a description of the type of reimbursement that is used for the ultrasound examination?
14. What is your opinion with regard to ultrasound examinations in general practice performed by general practitioners?
15. To what extent does, in your opinion, abdominal ultrasound in general practice leads to lower referrals to a medical specialist compared with abdominal ultrasounds performed in hospital care and diagnostic treatment centres?
16. What are the preconditions for performing abdominal ultrasound in general practice?
Closure
17. Is there anything that was not discussed during this interview, but it is important to mention? If yes, please feel free to bring up this subject.

Thank you again for participating in this study! If there are any questions or remarks as a result of this interview, please use the contact details provided in the information letter to contact us.

Kind regards,
[xxxxxxxx]