

BMJ Open Association of regulatory body actions and subsequent media coverage with use of services in a fee-for-service system: a longitudinal cohort study of CT scanning in Australia

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ABSTRACT

Objective The professional service review (PSR) is an Australian Government agency aiming to reduce inappropriate practices funded via Medicare, Australia's public insurer. Our objective was to examine changes in CT following the 2008–2009 PSR annual report, which noted excessive CT use.

Design Interrupted time series analysis examined trends in CT use following the 2008–2009 PSR report, estimating both change in the immediate rate of CT and the slope of the trend in usage postintervention.

Setting Medicare-funded imaging (most out-of-hospital imaging) in Australia.

Participants Patients receiving Medicare-funded CT and other imaging.

Intervention The 2008–2009 PSR report highlighted concerns regarding excessive CT use. Two providers were financially penalised for CT overuse with these cases detailed in the PSR report and highlighted in an associated Report to the Professions, distributed to 50 000 providers. Media articles on radiation risks followed.

Outcomes Quarterly rates of out-of-hospital CT, MRI (as a comparator), and all other Medicare-funded diagnostic imaging examinations 2001–2019.

Results CT scanning increased from 4663.5 per 100 000 person-years in 2001 to 14 506 in 2019 (211% increase), with substantial variation by type and anatomical region. The 2008–2009 PSR report was followed by an immediate reduction in CT scanning of 237.7 CTs per 100 000 people per quarter (95% CI –333.4 to –141.9) though growth in use soon continued at the preintervention rate. The degree of change in utilisation following the report differed between states/territories and by scan type, both in terms of the immediate change and the slope. For other diagnostic imaging modalities, there was an increase in the slope, while for MRI there was no change in either parameter.

Conclusion Actions consisting of financial disincentives for service overtesting and provider/public education components may limit excessive use of diagnostic imaging in fee-for-service systems, however, effects observed here were only short lived.

Strengths and limitations of this study

- This study made use of whole of population administrative data, improving generalisability and preventing loss to follow-up or non response.
- Multiple imaging modalities were examined, allowing for an assessment of CT (the target of the professional services review (PSR) actions) and potential substitution by other modes.
- Only data on publicly funded services accessed in the out-of-hospital setting were available; trends in in-hospital CT use were not examined.
- The PSR actions involved multiple components and it was not possible to examine specific components in isolation from each other.

INTRODUCTION

Overtesting is defined as the use of non-recommended screening tests in asymptomatic patients or more testing than necessary to diagnose patients.¹ Overtesting is problematic due to the wasted resources it incurs and the potential for patient harm. Harms of overtesting may fall under six domains²: physical, psychological, treatment burden, social, financial and dissatisfaction with healthcare. Overtesting with CT may manifest in many of these areas, for example, physical harms resulting from radiation exposure^{3 4} psychological harms resulting from incidental findings⁵ plus additional physical harms when these findings lead to further procedures or diagnostic tests.⁶ Overtesting also consumes healthcare expenditure without improving outcomes,¹ imposing an opportunity cost. Overtesting may result from intrapersonal (eg, fear of litigation, risk aversion, intolerance of uncertainty), interpersonal (eg, pressure from patients and colleagues) or contextual (eg, guidelines, financial incentives, time



constraints, test availability) factors.⁷ Studies in different countries have shown that over 10% of CT scans reflect overtesting,^{8,9} indicating substantial room for improvement in this area.

CT scanning in Australia is delivered in public and private hospitals, or in the out-of-hospital setting on referral from a general practitioner (GP) or specialist. Most out-of-hospital CT is performed by private clinics¹⁰ which are reimbursed on a fee-for-service (FFS) basis by the Federal Government via Medicare, Australia's public insurer, which covers almost all Australian citizens and permanent residents¹¹ (with prisoners an exception). Similarly, GPs operate in private practices which are reimbursed by Medicare on an FFS basis hence are incentivised to maximise service volumes.¹² Patients do not register with practices and are free to change providers at any time, so multiple providers compete for services in the out-of-hospital environment, potentially driving overtesting where patients expect certain medical interventions (such as diagnostic CT) and providers feel compelled to meet patient expectations so as to prevent the patient from being 'lost' to another GP who provides or refers for the expected service.^{13,14} Note that decisions regarding out-of-hospital CT scanning are primarily made by referrers (GPs and specialists); radiologists at private clinics generally do not know the setting or patient and are not well positioned to deny scans requested. Although Medicare provides reimbursement for CT scans referred by a GP, MRI scans are generally only reimbursed when referred by a specialist (with some exceptions since 2011).¹⁵ Furthermore, MRI machines must be licensed by the Federal Government in order for scans using that machine to attract reimbursement, with license availability restricted.¹⁵ This may limit substitution of CT scans by MRI. No such restrictions exist for other modalities.

One of the bodies regulating healthcare in Australia is the professional services review (PSR), which has responsibility for preventing inappropriate practice, both to protect patients from risk and to reduce government funding of inappropriate care.¹⁶ The PSR reviews the activities of practitioners where unusual service volumes or prescribing patterns suggest inappropriate care. On investigation by the PSR, a practitioner found to have engaged in inappropriate practice (as determined by a peer panel of practitioners) may be partially or fully disqualified from claiming Medicare reimbursements for some time, may be required to repay reimbursements claimed for delivery of inappropriate care, or may face suspension from practice.¹⁷ In the 2008–2009 PSR annual report published in October 2009, two providers were penalised for CT overtesting. In addition, the Director's report within the annual report commented on CT overtesting, noting concerns about use of CT screening for lower back pain.¹⁸ Alongside this annual report was the dissemination by the PSR of a Report to the Professions to 50 000 health providers detailing these cases (and others), and the PSR director also spoke at medical conferences and to the media.¹⁸ This was followed by a

period of media interest concerning CT risks, including the publication of articles highlighting the risks of CT, targeted at both clinical audiences^{19,20} and the general public.^{21–24} These articles, published through 2010 and 2011 in national^{22,24} and state-specific media,²³ outlined the PSR director's concerns, cancer risks associated with CT, the role of patient expectations as a factor and alternative imaging modalities. These events are collectively referred to as 'the PSR actions' throughout this paper for simplicity. Any change in CT scanning resulting from the PSR actions may reflect either a change in imaging levels overall, or shifts to other modalities.

The aim of this project was to examine the impact of the PSR actions on the rate of CT scanning in Australia, to determine if regulatory body action influences overtesting in the FFS context.

METHODS

This was a retrospective whole-of-population longitudinal cohort study using aggregate-level administrative data. Reporting follows the Reporting of studies Conducted using Observational Routinely collected health Data (RECORD) guidelines.²⁵

Data source

Quarterly utilisation data for Australia and for each Australian state/territory from January–March 2001 to October–December 2019 inclusive were sourced from publicly available Medicare Benefits Schedule (MBS) records.²⁶ Data pertaining to CT were extracted using MBS item reports. Data for other Medical Imaging modalities (Ultrasound, Nuclear Medicine and MRI) were extracted using the group report for category 5 Diagnostic Imaging Services. Data included only those services performed by a registered provider for services that qualify for Medicare Benefits and for which Services Australia had processed a claim. Data excluded services provided by hospital doctors to public patients in public hospitals and services that qualified for a benefit under the Department of Veterans' Affairs National Treatment Account. These services are not within the purview of the PSR, nor are records of these services available with the MBS data used for the current study. The location services were provided (state/territory) was based on patient address. Calendar quarter was determined by the date of processing by Services Australia, not the date the service was provided to the patient. Note that date of processing is typically within days of the service date. For the denominator the Medicare eligible population for each state/territory was sourced from Medicare enrolment data quarterly standard reports.²⁷

CT scanning data were aggregated into fourteen groups reflecting either anatomical area of the scan (eg, head, chest) or, due to lack of anatomical location on the MBS coding, grouped according to technique (cone beam CT, pelvimetry, spiral angiography and interventional CT) using the MBS item codes in online supplemental

appendix 1. Since MBS items are for reimbursement rather than clinical purposes, several items covered multiple CT examinations (chest, abdomen/pelvis and brain, chest/upper abdomen). For analysis, all CT scanning records pertaining to these items were counted as a single CT scanning event. In the analysis by type of CT these items were grouped separately (see online supplemental appendix 2) and were not included in the analysis of their relevant sub-groups (ie, brain, chest or abdomen/pelvis).

Quarterly rate of imaging

The annual rate of MBS-funded imaging per 100 000 eligible persons was calculated for all Australia and by state/territory by dividing the number of services processed in that year by the eligible Medicare population for that year multiplied by 100 000.

Statistical analysis

Interrupted time series analysis (ITSA) was used to evaluate the impact of the PSR actions on the quarterly rate of medical imaging excluding CT, MRI, all CT scanning and type of CT scanning for all Australia and by state/territory.

The analysis was conducted using the ‘*itsa*’ package²⁸ in Stata V.15.²⁹ Since the PSR actions affected the whole of Australia a control group was not available for comparison, therefore, the model was a single-group ITSA (ie, the preintervention trend was projected into the postintervention period to serve as the counterfactual) with a dummy indicator variable set to quarter 4 2009 representing the PSR action. Coefficients were estimated using ordinary least squares regression with Newey-West standard errors to handle autocorrelation and heteroskedasticity.

Each model was first fitted with lag 0 specified (ie, no autocorrelation), following which autocorrelation in the error distribution was tested for using the programme ‘*actest*’³⁰ and the appropriate lag used in the final model. The model was implemented after adjustment for seasonality using Fourier terms (pairs of sine and cosine functions)³¹ using the programme ‘*circular*’.³² Following Imbens and Lemieux³³ the median timepoint (quarter 4, 2004) of the preintervention period was used as a robustness test to determine if the underlying assumption of stability in time-varying unmeasured confounders should be challenged. Where the postintervention trend was non-linear, multiple dummy variables were used to adequately capture the shape of the postintervention trend so that a more accurate estimation of the immediate change in the trend and change in level resulting from the PSR action could be estimated.

Classification of response to the 2009–2010 PSR

For each model the direction and statistical significance of the estimates of the level (initial change in the quarterly rate of CT use) and slope (gradient of the trend in quarterly CT use) parameters in the postintervention period (or for the slope the immediate postintervention segment

where a non-linear trend was observed) were used to classify the response to the PSR action. The primary typology was based on the direction and significance of the level parameter as follows: type 1: significant reduction in the level; type 2: no significant change in the level and type 3: significant increase in the level. Each type was further classified into subtypes based on the change in the slope parameter: (1) significant reduction; (2) no significant change and (3) significant increase.

Calculation of net change in CT imaging procedures following the PSR action

The net change in the CT procedures performed was calculated from the area between the counterfactual (ie, preintervention slope with no level change) and the postintervention observed (defined using the seasonally adjusted model level and slope parameters) curves of the quarterly rate of imaging procedures. To reduce overestimation of the net change where no significant difference was observed between the preintervention and postintervention slopes (ie, subtype b) the preintervention slope parameter was used to define the postintervention slope rather than the point estimate provided in the ITSA model. Similarly, where no significant difference in level was observed (ie, type 2), the postintervention curve was defined with the level change set to zero. When the postintervention trend was non-linear the net change was only calculated until the beginning of the subsequent change in trend. The net change could be negative (ie, net reduction in the rate of imaging examinations through the postintervention period) or positive.

Patient and public involvement

As this is an analysis of secondary data, there was no patient or public involvement.

RESULTS

Over the 19-year study period, 369.5 million Medicare-funded medical imaging examinations were undertaken in Australia (6.2% of all Medicare-funded activity) of which CT scanning comprised 11.4% (42.2 million) (online supplemental appendix 2). The most frequently performed type of CT scan was abdomen/pelvis comprising 18.8% (~8 million) of all CT examinations, closely followed by head CT (17.6% (7.5 million)) and spinal CT (17.6% (7.4 million)).

As shown in [table 1](#), the rate of CT scanning increased from 4662.2 per 100 000 Medicare eligible persons in 2001 to 14505.2 per 100 000 in 2019. The increase of 211% was much larger than the increases observed for ultrasound (+150%) and nuclear medicine (+96%), or for diagnostic imaging overall (75%). While the largest increase in the rate of imaging (by modality) was observed for MRI (increasing by ~400% over the study period), the absolute rate was still 64% lower than the rate of CT scanning in 2019. [Table 1](#) also shows the rate of CT scanning according to type across the study period. In 2001 the top



Table 1 Annual rate of MBS-funded diagnostic imaging by modality and type of CT scanning services in Australia across the study period

Year	Rate per 100 000 eligible population						Rate of CT per 100 000 eligible population					
	All diagnostic imaging	MRI	US	Nuc med	All CT	Head	Face	Soft tissue neck	Chest			
2001	62 815.20	1056.10	17 753.80	1494.80	4662.20	1529.90	629.9	119.4	519			
2002	64 018.20	1173.00	18 540.80	1514.50	5993.70	1522.60	630	125.6	558.8			
2003	64 489.60	1270.30	19 310.30	1517.10	6304.30	1543.40	624.1	130.6	586.6			
2004	65 657.10	1350.00	19 929.00	1522.90	6663.80	1546.30	640	135.6	631.1			
2005	70 767.70	1558.40	22 127.80	1588.50	7428.70	1662.20	699.2	148.8	695.2			
2006	73 155.60	1776.10	23 344.80	1617.60	7941.90	1697.70	738	156.3	724.8			
2007	76 179.30	1958.40	24 717.90	1684.10	8516.50	1779.10	764.1	163.8	765.5			
2008	78 983.80	2050.00	26 189.10	1801.80	9036.20	1815.10	808.6	170.6	803			
2009	82 260.00	2252.70	28 004.90	1980.30	9592.60	1874.30	840.9	178.3	834.9			
2010	83 548.70	2346.90	29 065.00	2138.80	9085.60	1745.40	772.4	171.8	793.2			
2011	86 766.50	2501.10	30 801.00	2334.20	9615.50	1739.70	787.5	181.8	854.9			
2012	90 623.80	2640.90	33 148.70	2544.40	10674.40	1812.40	819.7	192.9	923.1			
2013	94 223.40	3003.00	35 368.00	2677.70	11 246.60	1837.80	827.2	203.9	986.7			
2014	98 378.10	3891.20	36 959.40	2727.90	11 705.00	1760.80	843.5	212.7	1068.20			
2015	99 830.50	4107.90	38 121.70	2717.40	11 698.90	1756.70	845.6	217	1140.50			
2016	101 767.50	4249.20	39 553.80	2694.50	12 098.00	1753.30	840.3	232.6	1221.70			
2017	106 182.50	4653.20	41 481.60	2814.20	13 008.90	1842.10	880.3	253.1	1345.50			
2018	108 783.70	4927.40	43 087.80	2850.30	13 744.10	1875.90	909.7	268.8	1422.70			
2019	110 010.00	5277.30	44 452.10	2925.40	14 505.20	1884.40	930.1	294.4	1552.00			
Per cent change total 2001 to total 2019*	75.1	399.6	150.4	95.7	211.1	23.2	47.7	146.5	199			

Year	Rate of CT per 100 000 eligible population							
	Abdomen/pelvis	Pelvis	Spine	Chest/abdomen/pelvis	Extremity	Spiral angiography	Interventional CT	Cone beam
2001	1018.90	68.5	N/A	227.2	195.3	85.5	95.3	N/A
2002	1124.90	70.3	1229.20	268.4	213.8	107	120.6	N/A
2003	1223.40	74	1275.80	311.1	229.3	131.5	151.4	N/A
2004	1320.30	75.2	1328.60	361	249.5	166.2	184.8	N/A
2005	1465.50	78.5	1470.10	433.2	292.6	219.4	237.2	N/A
2006	1579.60	83	1575.40	495.4	332.4	249.3	281.1	N/A
2007	1687.70	89.5	1718.10	549.7	374.5	273.7	321.2	N/A
2008	1780.40	99	1834.80	599.8	417.9	301.2	374.6	N/A

Continued

Table 1 Continued

Year	Rate of CT per 100000 eligible population									
	Abdomen/pelvis	Pelvis	Spine	Chest/ abdomen/pelvis	Extremity	Spiral angiography	Interventional CT	Cone beam		
2009	1898.20	90.9	1911.50	677.6	470.7	329.5	451.6	N/A		
2010	1782.40	85.4	1693.50	701	455.4	342.2	508.4	N/A		
2011	1842.80	89.4	1714.50	766.9	496.3	410.8	563.4	N/A		
2012	1987.80	98.8	1899.00	855.4	566.8	517.2	656	300.3		
2013	2081.80	111.7	1973.20	907.8	610	575	738.7	342.5		
2014	2149.10	124.9	2043.80	968.4	661.8	604.3	825.4	387.9		
2015	2164.60	143.2	2007.80	1011.50	681.4	642.9	869.5	157		
2016	2219.80	171.9	2010.50	1068.10	718.3	706	911.5	166.1		
2017	2352.60	204	2144.50	1138.00	782.8	798.3	992.7	175.3		
2018	2474.90	248.3	2229.00	1202.00	873.6	881.6	1042.70	183.2		
2019	2565.00	313.4	2237.20	1253.00	989	986.8	1133.80	191.8		
Per cent change total 2001 to total 2019*	151.7	357.8	30.2	451.3	406.5	1053.90	1089.20	-44		

Grey cells indicates that MBS-funded services were not available for all or part of the specified time period.

*Where MBS item was not available in for the whole of 2001 percentage change is calculated from first year it was available in all quarters.

MBS, Medicare Benefit Scheme; Nuc Med, Nuclear Medicine; NA, item not available; US, ultrasound.

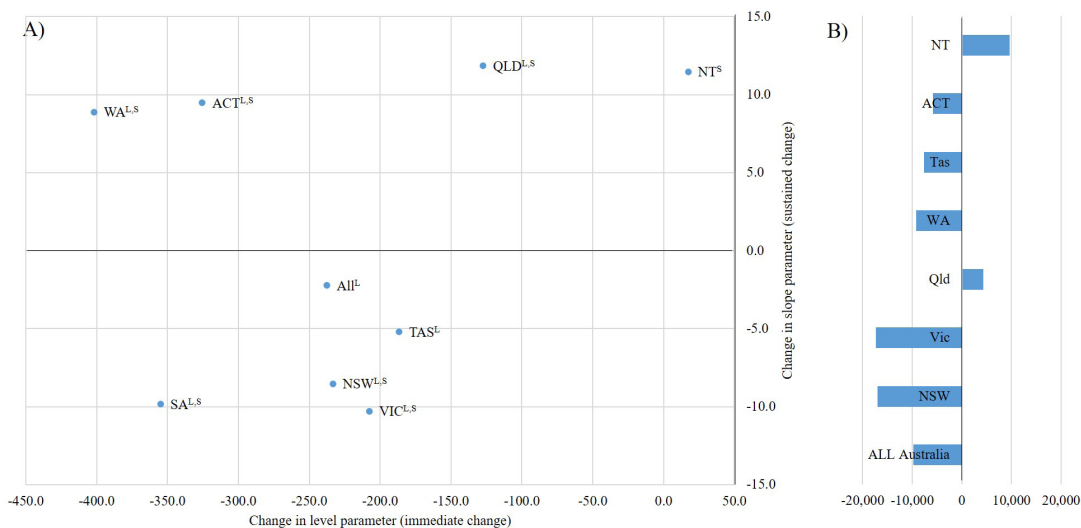


Figure 1 (A) indicates change in the quarterly rate of MBS-funded CT scans per 100 000 eligible population according to geographical location of service provision following publication of the MBS professional services review (2008–2009) and associated media attention. Superscript L and S indicate significant changes in the level and slope parameters, respectively. B) indicates net change in rate of CTs performed Qtr3 2009–Qtr4 2019, by state. MBS, Medicare Benefits Schedule; WA, Western Australia; SA, South Australia; VIC, Victoria; NSW, New South Wales; TAS, Tasmania; NT, Northern Territory; QLD, Queensland; ACT, Australian Capital Territory.

three types of CT scanning, ranked according to the rate performed per 100 000 persons, were head CT (1529.9), followed by abdomen/pelvis CT (1018.9) and CT of the facial bones (629.9). However, by 2019, this ranking had changed such that abdomen/pelvis CT had the highest rate per 100 000 (2,565.0); spinal CT was now ranked second (2237.2) and head CT third (1884.4). The largest relative change in the rate of CT scanning by type from 2001 to 2019 was observed in interventional CT which increased by 1089% (from 95.3 per 100 000 in 2001 to 1133.8 in 2019). Similarly, the rate of spiral angiographic CT scanning also rose by 1054% (from 85.5 per 100 000 in 2001 to 986.8 in 2019). Other notably very large relative increases (ie, more than tripling of the 2001 rate) were observed for chest/abdomen/pelvis CT (+451%), CT of the extremities (+407%) and pelvis CT (+358%). Rate increases of over 100% were observed for chest CT (+199%), abdomen/pelvis CT (+152%) and soft tissue neck CT (+147%). The only type of CT scan to reduce in rate was cone beam CT which was first funded under Medicare in 2011 (quarter 3).

Figure 1 shows the results of the ITSA evaluating changes in the use of CT following the PSR actions, by state/territory; values informing the figure are in online supplemental appendix 3. On average after adjusting for seasonality and autocorrelation there was a significant reduction in the level parameter (–237.7 CTs per 100 000 Medicare eligible persons (95% CI –333.4 to –141.9)) indicating an immediate response. However, no significant change in the slope parameter was observed, indicating no sustained effect, that is, following the initial drop in utilisation, growth in CT scanning continued at its previous rate. Despite there being no sustained change, over the postintervention period (Qtr 4 2009–Qtr 4 2019) the cumulative

rate (ie, the net change) of CT use reduced by 9744.3 per 100 000 due to the initial level change, compared with the counterfactual. This can be readily observed graphically in figure 2. Across Australian states and territories, the response differed (figure 1). In all states/territories except the Northern Territory there was a significant reduction in the level; however, the response in the slope parameter differed. In New South Wales, South Australia and Victoria there was a significant reduction in the slope parameter (ie, sustained reduction), in Tasmania there was no significant change in the slope, while in the Australian Capital Territory, Queensland, Western Australia and the Northern Territory after the initial reduction in level there was a significant increase in the slope parameter.

Figure 3 shows the results of the ITSA according to type of CT scanning in Australia (values in online supplemental appendix 3). The majority of CT scanning types showed an immediate significant reduction in level, the exceptions being CT angiography and chest/abdomen/pelvis CT which showed no change, and interventional CT, which showed an increase in level. With respect to sustained change (ie, slope) there was a much larger variation across type with reductions (head, face, abdomen/pelvis, spine CT and CT angiography), increases (chest, extremity, soft tissue neck, brain/chest/upper abdomen and interventional CT) and on one occasion no change (pelvis CT) observed. Figure 3 also shows the results of the analysis for MRI, which showed no response in either parameter and all diagnostic imaging excluding CT, which showed no change in the level but an increase in the slope parameter. Changes for all diagnostic imaging excluding CT are also presented in figure 4, displaying the change in the slope parameter through the postintervention period.

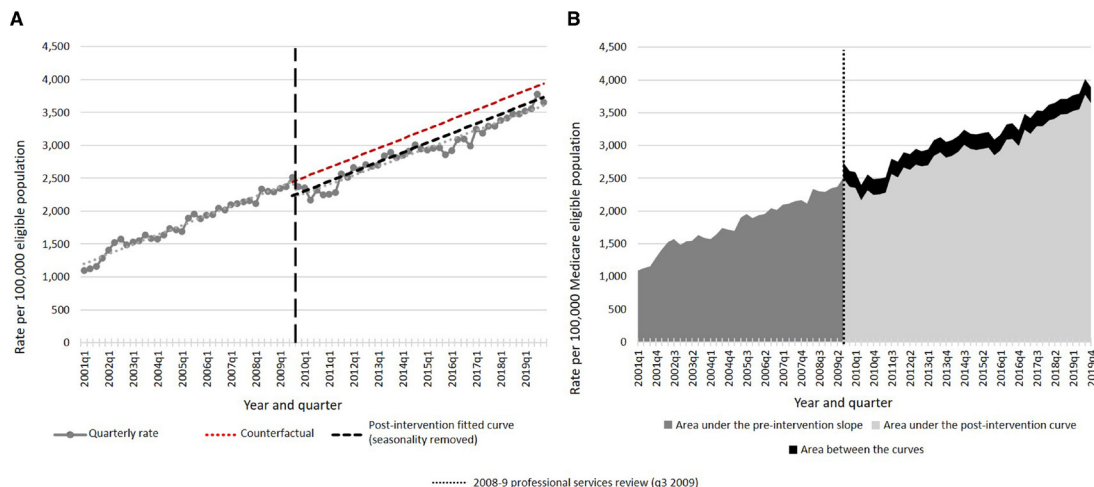


Figure 2 Impact of the 2008–2009 professional services review on the rate of Medicare-funded CT scanning (per 100 000 Medicare eligible population) in Australia. (A) indicates quarterly rate of all MBS-funded CT scans showing counterfactual and postintervention fitted line (seasonality removed for simplification). (B) is a representation of the seasonally adjusted area under and between the curves used to estimate net effect of the response to the MBS professional services review 2008–2009. MBS, Medicare Benefits Schedule.

DISCUSSION

CT use reduced significantly following the 2008–2009 PSR annual report, associated sanctions and subsequent media coverage of CT risks. Following this short-term decline, CT use continued increasing at the preintervention rate, though results differed by scan type/region and state/territory. Findings indicate that major reviews including financial penalties and surrounding coverage have potential to decrease overtesting, but that reductions may not be sustained.

Being an observational study we cannot assume causation, though we highlight some important points in considering this. There was a close temporal relationship between the PSR report and the changes in CT use, which

would be expected if changes were causal. The face validity of a causative relationship can be considered via the overtesting framework developed by Lam *et al.*⁷ Interpersonal drivers of overtesting may have influenced CT use as the mass media coverage outlined radiation risks to patients and included some discussion of the role of patient expectations in driving imaging requests.^{22–24} On the provider side, fear of reputational damage following a reprimand is also an interpersonal factor. Environmental drivers may have changed if providers grew concerned about financial penalties from the PSR for excessive imaging. Intra-personally, the risk aversion that drives overtesting in the search for a definitive diagnosis may have been countered by improved knowledge of radiation risks.

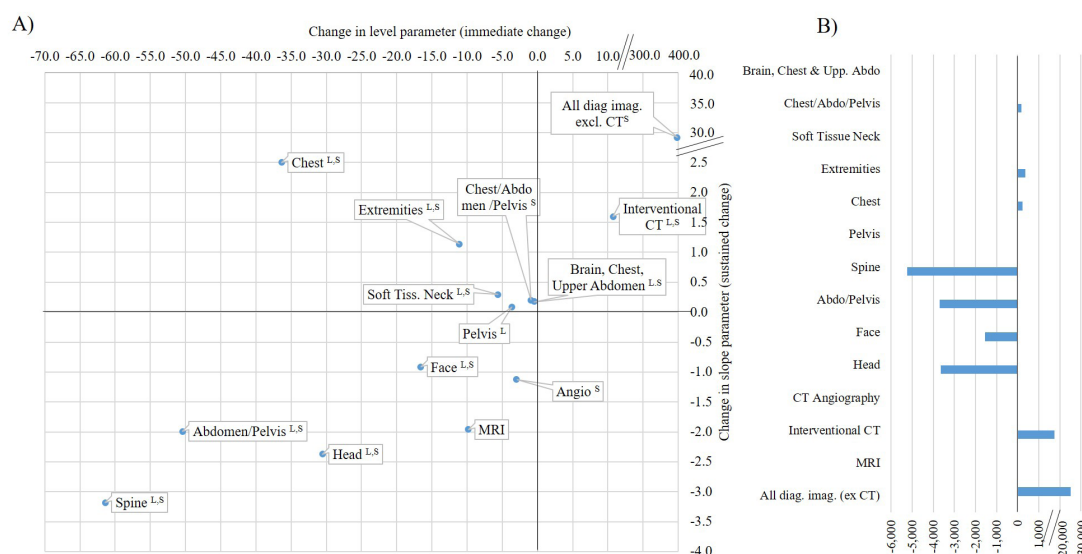


Figure 3 (A) Change in the quarterly rate of MBS-funded medical imaging undertaken in Australia per 100 000 eligible population according to type of service following publications of the MBS professional services review (2008–2009) and associated media attention. Superscript L and S indicate significant changes in the level and slope parameters, respectively. (B) displays net change in rate of CTs performed Qtr3 2009–Qtr4 2019, by type/anatomical area. MBS, Medicare Benefits Schedule.

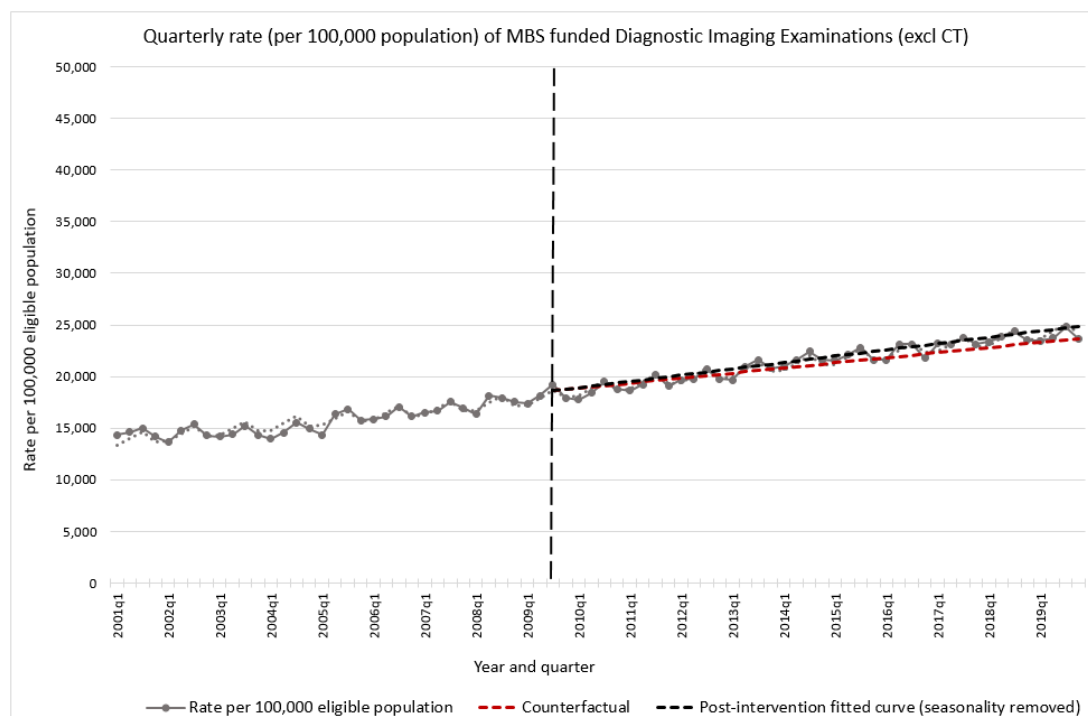


Figure 4 Impact of the 2008–2009 professional services review on the rate of Medicare-funded diagnostic imaging excluding CT (per 100 000 Medicare eligible population) in Australia. Figure indicates quarterly rate of all MBS imaging claims (excluding CT) showing counterfactual and post-intervention fitted line (seasonality removed for simplification). MBS, Medicare Benefits Schedule.

The risk of reputational damage or financial penalties was low, with the PSR report discussing two providers sanctioned for inappropriate CT. However, these cases were widely disseminated, via the Report to the Professions describing these cases (and others) to 50 000 providers. Furthermore the PSR director speaks at national medical conferences and to the media about PSR activities,¹⁸ and attends meetings of medical colleges and the Australian Medical Association to further raise awareness of PSR activities.³⁴ Although we are not aware of any surveys or other material describing awareness of the PSR among providers or patients, the dissemination activities outlined above likely led to a reasonable degree of awareness among providers. Moreover, a 2011 review of diagnostic imaging noted that the 2008–2009 PSR had likely impacted practice, and that private providers had expressed concerns regarding profitability following this.³⁵ Penalties for inappropriate CT appeared in the 2009–2010 and 2011–2012 PSR annual reports, however, there was no specific discussion of CT in the director's reports nor are we aware of media coverage following these reports.

There is prior evidence in Australia of educational interventions reducing CT. In 2013 the National Prescribing Service's MedicineWise programme ran an intervention to reduce inappropriate CT for acute lower back pain.³⁶ This included a report to GPs comparing their referral rates for lower back CT to their peers, an online decision support tool and a symptom self-management prescription pad. The intervention reduced lower back CT by over

10%, which persisted through 20 months follow-up. This demonstrates some receptiveness to messaging regarding CT overtesting, though mechanisms of action by which the PSR may have influenced practice would differ. Similarly, the introduction of a Choosing Wisely recommendation to reduce imaging for lower-back pain in the United States in 2012 was followed by a 4% reduction in such imaging.³⁷ The Choosing Wisely campaign regarding lower back CT in the USA did not involve any financial disincentives such as the PSR actions in the current study, though did garner substantial media attention³⁷ so some drivers of change may have been comparable. A review of interventions to reduce overuse care suggested that educational interventions targeted at both clinicians and patients are among the most effective type,³⁸ supporting the notion that media coverage on CT overtesting may have influenced practice.

Results here differed between states/territories and CT type. Differences in results across CT type do not appear to be driven by differences in the radiation dosages associated with each type, given that chest/abdomen/pelvis scans showed no change in either parameter following the PSR action but expose patients to some of the highest effective doses.³⁹ Differences observed between states/territories may have resulted from differences in the baseline level of CT use; this is likely as availability of CT scanners, one driver of overtesting, does differ between jurisdictions.¹⁵ These differences may have also resulted from differences in messaging in each state/territory, caused by either different levels of media coverage of this

issue (as some coverage appeared in local²³ rather than national newspapers), or addresses by the PSR director to medical conferences in some states but not others. Baseline attitudes towards CT, and hence the capacity for reductions in use, may have also differed between networks of providers, given the concentration of scanners and providers in capital cities¹⁵ which are in many cases geographically isolated.

There were differences observed between CT and other modalities. In contrast with the drop in CT use following the PSR, MRI showed no change following the 2008–2009 PSR report, while for all diagnostic imaging excluding CT the slope increased significantly, while the level parameter showed a large but non-significant increase. This may represent substitution for modalities with lower or no associated radiation exposures (eg, X-ray or ultrasound, respectively). MRI use increased steadily through the study period, reflecting an increase in availability of MR machines from below to above average in comparison to other Organisation for Economic Co-operation and Development countries.⁴⁰ There was no additional increase in use of MRI following the PSR actions, however, likely because licensing of MR devices is constrained by the Federal Government and most MRI investigations are not reimbursed by Medicare when referred by a GP, limiting potential for substitution.^{41 42} Alternatively, there may have been an increase in privately funded MRI which would be unobservable in the Medicare data used here.

Implications

Although the PSR actions were followed by a reduction in CT use, growth then continued at the preintervention rate. This suggests that although such actions may be influential, any resulting changes in behaviour may not be sustained in the absence of ongoing intervention. As the PSR publishes annual reports there may be opportunities to replicate the actions assessed here, if media interest in the topic could be sustained, which may produce longer-term changes in CT use.

These findings will be of interest to researchers and policymakers wanting to understand mechanisms to prevent overtesting, though contextual factors are important in understanding how effective such actions may be elsewhere. Provider and patient education regarding radiation risks, threats of financial penalties and reputational damage following exposure of inappropriate practice would likely be influential mechanisms across settings. The degree of response to such mechanisms, however, would depend in part on the baseline level of overtesting, driven in part by health system design. In health systems where providers are paid via capitation or salary rather than FFS overtesting may be less common, with FFS systems known to incentivise service volumes.⁴³ Similarly, in some health systems patients register with a practice⁴⁴ and cannot ‘doctor-shop’ as is the case in Australia. In such systems providers are not financially incentivised to increase patient satisfaction by delivering requested services, as patients cannot simply access the service via

another practice. Overtesting may be incentivised where pay-for-performance programmes prioritise patient satisfaction, as providers may feel pressured to refer patients for requested imaging services so as to maintain satisfaction ratings.⁴⁵ Relationships between providers referring for imaging and those performing imaging may also influence overtesting, for example, ownership by physicians of radiology services is associated with increased radiology use.⁴⁶ A shift from a volume-driven to a value-driven system could prevent overtesting by focusing on the delivery of interventions to maximise patient outcomes rather than service delivery.⁴⁷ Finally, the PSR actions studied here were facilitated in part by the existence of the PSR which has oversight of all Medicare-funded services and authority to impose penalties. Although the PSR objectives of patient safety and cost containment are priorities globally, mechanisms available to regulators will differ elsewhere.

Strengths

This study benefited from the use of whole of population administrative data, improving generalisability and preventing loss to follow-up or nonresponse. The data cover a long study period both prior to and following the PSR action, improving effect estimates and covers multiple imaging modalities. The analysis accounted for potential seasonality in the use of CT and non-linearity in postintervention trends.

Limitations

Data were limited to services funded via Medicare Australia. Comparable data concerning patients in public hospitals were not available, and we cannot comment on potential trends in that setting.

There was no comparator available, which may have supported a more rigorous design. The PSR has a national scope, meaning there was no setting without the PSR action against which to compare trends. Different sets of MBS items were assessed as comparators in the hope of providing control for broader health system changes, but no items could be found for which preintervention trends resembled CT.

The data used did not allow for services to be assessed at the level of individual provider. As the PSR targets providers with unusually high volumes of services, it is possible that CT reductions following the PSR were concentrated among a small number of practitioners with high CT referral rates, alternatively it is possible that media messaging led to a more uniform change across providers. We could not assess provider-specific effects due to this data limitation.

Rates here used the Medicare-eligible population as the denominator, though changes in the number of people presenting for care may also be a suitable denominator as changes in this may impact CT use. The quarterly counts of GP contacts were included and show no change around the time of the PSR actions which would account for changes in the rates of CT observed.



This study examines an action consisting of multiple components, and we are not able to assess, for example, mass media coverage in isolation from the publication of financial penalties for overtesting.

CONCLUSION

This study suggests that regulatory body action may influence provider behaviour within an FFS context. However, it also suggests that point-in-time interventions have limited longevity. The combination of financial incentives (ie, penalties for excessive use), patient and provider education, and risks to reputation via potential for publicising of investigation outcomes was followed by reduced CT use. Further research examining how best to couple such actions with more sustained reinforcement over time to influence behaviour would be useful, in addition to studies assessing the proportionate impacts of individual components.

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