
ORIGINAL ARTICLE

Cost Effectiveness Analysis of Protocol Driven Intravenous Urogram Performed by Radiographers

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ABSTRACT

Aim: To assess the cost-effectiveness of protocol driven intravenous urogram performed by radiographers compared with that performed with a radiologist overseeing the whole examination (non-protocol driven intravenous urogram).

Patients and Methods: 200 patients were randomly selected between December 2001 to August 2002 to receive protocol driven intravenous urogram (100) or non-protocol driven intravenous urogram (100). The number of contrast extravasations, contrast reactions, and total time for the examination were recorded. The number of films, the volume of contrast, and the number of staff for each group were included in the estimation of the cost of the examination.

Results: No significant difference was found in commitment of the final reports for the two methods. Eighty eight percent of protocol-driven intravenous urogram examinations resulted in a diagnosis. Protocol driven intravenous urogram and non-protocol driven intravenous urogram partially answered or failed to answer the clinical question for 12% and 13% of patients, respectively. Only 4% of protocol driven intravenous urograms (4 patients) were sub-optimal and related to insufficient views for examination. There was no statistically significant difference in consumption, volume of contrast, and time taken for the examination. There was a significant difference in the consumption of films — on average 2 additional films were used for the protocol driven intravenous urogram examination. The manpower demand for intravenous urogram examination decreased by 40%. The productivity of intravenous urogram examination could increase by 67%. The estimated cost of an intravenous urogram examination decreased by 27%.

Conclusion: The productivity and efficiency of protocol driven intravenous urogram has significantly improved while the cost of intravenous urogram examination has significantly decreased without degradation of quality. A more extensive utilisation of protocol driven intravenous urogram is therefore advocated.

Key Words: Cost effectiveness, Intravenous, Urography

INTRODUCTION

To save manpower and redistribute the resources of the department, more radiological procedures are now performed by radiographers and nurses by process re-design. Several studies have suggested that it is cost-effective for barium enemas to be performed by radiographers.^{1,2} Chalmers et al suggested that experienced nurses and radiographers could rapidly acquire the skills to perform diagnostic angiography safely and efficiently.³ Boulton et al also suggested that

specialist nurses with appropriate experience can be trained to perform standard transfemoral cardiac catheterisation procedures safely and competently for low risk patients.⁴ Studies have suggested that the radiographer has an important role in the preliminary interpretation of chest radiographs in a cardiothoracic unit⁵ and following mammography.⁶ However, no one has tried to analyse the cost effectiveness of intravenous urogram (IVU) examinations performed according to a protocol without a radiologist present. In this study, the protocol driven IVU (PD-IVU) examinations were mainly performed by a team of well-trained and experienced radiographers.

A radiologist working near the IVU examination room was on standby for any medial emergency. The

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Box 1. The protocol driven intravenous urogram. The necessity of oblique views and erect films are decided by the radiographer.

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- Preliminary film
 - Nephrogram
 - 5 minutes film
 - 12 minutes film
 - Tomograms
 - Supine and prone release films
 - Full bladder film
 - Post-micturition film
 - ± Oblique films
 - ± Erect film
-

radiographers were responsible for intravenous access, contrast injection, and filming according to the protocol (Box 1). Additional films were performed if indicated. All films were finally reported on by radiologists.

This study examined whether the quality of the final radiological report was degraded by the protocol driven examination. Other parameters including patient's safety, contrast reaction, contrast extravasation, cost per examination, and the length of time for the report endorsement were also analysed.

PATIENTS AND METHODS

200 IVU examinations were randomly selected from a pool of PD-IVU and non-protocol driven (NPD) IVU examinations performed between December 2001 and August 2002. These included 100 PD-IVUs and 100 NPD-IVUs. The incidence of contrast extravasation, contrast reaction, number of films, and time for examination were recorded. Boxes 1 and 2 show the procedures for PD-IVU and NPD-IVU.

The radiological reports were reviewed and the limitations mentioned in each examination were recorded. The quality of radiological reports were classified into 3 groups, namely:

- answers the clinical question
- does not answer the clinical question
- partially answers the clinical question. The second and

Appendix 2. The non-protocol driven intravenous urogram.

-
- Preliminary film
 - Nephrogram
 - 5 minutes film
 - 12 minutes film
 - Tomograms
 - Supine release films
 - Full bladder film
 - Post-micturition film
 - ± Oblique films
 - ± Prone release film
 - ± Erect film
-

third groups were classified into whether the inability to answer the clinical question was related to the type of examination. The reporting time and total examination time taken were also compared. The number of staff and films for each group were included in the cost of each examination. The mid-point of the Hospital Authority pay scale for the radiographers and radiologists was used for comparison.

RESULTS

There were no statistically significant age differences between the 2 groups. The mean age for PD-IVU was 58.7 years and for NPD-IVU was 54.7 years. The average years of experience of the radiographers and radiologists were both more than 5 years. No supplementary ultrasound was performed for these patients.

Figure 1 illustrates the difference between PD-IVU and NPD-IVU in respect of answering the clinical question. In the PD-IVU group, 88% of patients (88/100) were diagnosed, while for 12% (12/100) the clinical question was only partially answered or was not answered. Of these, 4 were due to the protocol — mainly due to insufficient views (oblique views) — 7 were limited by poor bowel preparation and 1 was due to a poor pyelogram relating to poor renal function. These results were comparable with the NPD-IVU group with no significant difference.

In the NPD-IVU group, 13% of patients (13/100) were not fully diagnosed, even with a radiologist in charge of the whole examination. The reasons included a problem in which the ureters could not be opacified, poor renal function, and poor bowel preparation.

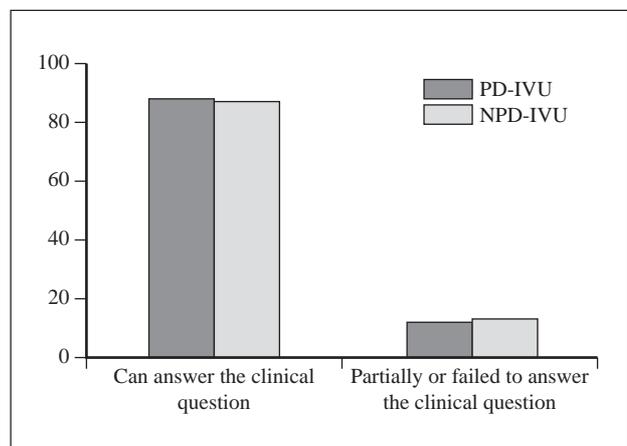


Figure 1. Histogram illustrating the difference between protocol driven intravenous urogram (PD-IVU) and non-protocol driven intravenous urogram (NPD-IVU) in respect of answering clinical questions.

Table 1. Comparison of different parameters in non-protocol driven intravenous urogram (NPD-IVU) and protocol driven intravenous urogram (PD-IVU) examinations.

	NPD-IVU	PD-IVU
Average volume of contrast per examination (ml)	74.7	73.1
Average number of films per examination	9.7	11.6
Average time per examination (minutes)	121.3	115.2
Number of contrast extravasation	0	0

Table 2. Comparison of different parameters related to the average estimated cost of each non-protocol driven intravenous urogram (NPD-IVU) and protocol driven intravenous urogram (PD-IVU) examinations (excluding cost of the machine and film processing). Costs are in HK\$.

	NPD-IVU	PD-IVU
Radiologist	\$1273	\$764
Radiographer	\$503	\$503
Contrast	\$100	\$90
Films	\$29	\$33
Total cost	\$1905	\$1390

Table 1 compares the different parameters between PD-IVU and NPD-IVU examinations in terms of volume of contrast used, number of films used, time length, and number of contrast extravasations. Table 2 compares the estimated cost of each IVU examination between the 2 groups, excluding the cost of the machines and film processing). There were no significant differences in the volume of the contrast used and the average length of time for each examination. However, there was a significant difference in the consumption of films, with an average of 2 more films used for the PD-IVU examination ($p < 0.001$). There was no extravasation of contrast or allergic reaction in these patients.

Using PD-IVU, radiologists can now report 10 IVU examinations in the morning session and 7 in the afternoon session compared with 6 examinations in the morning and 4 in the afternoon previously. The mid-point of the Hospital Authority pay scale for the radiographers and radiologists was used for the calculation of the estimated cost of the staff for each examination. The number of films for each group and the volume of contrast were also included in the final estimation of the cost. Each PD-IVU examination was estimated to cost HK\$1390 while each NPD-IVU examination cost HK\$1905. There was, therefore, a 27% reduction in cost for each examination. However, the average reporting time increased for PD-IVU (10 days) when compared with NPD-IVU (2 days).

For PD-IVU, only 4 of 12 patients needed further imaging (ultrasound or computed tomography scan).

This was comparable with the NPD-IVU examination for which 4 of 13 patients needed further imaging.

DISCUSSION

There is a recent trend to save radiological manpower and to redistribute resources in radiology departments. More radiological procedures are now being performed by radiographers and nurses under supervision.¹⁻⁴

For standard IVU examinations, radiologists need to wait for the whole examination to finish before they can write up the report. Therefore, only a limited number of patients (approximately 4 to 8) can be managed in one session. If the investigation is straightforward, more examinations may be performed while maintaining the quality of the investigation. Protocol driven examination is potentially viable.

The IVUs can be performed by the radiographer under supervision and later reported by a radiologist, making it more efficient and cost-effective. These results suggest that there is no significant difference in terms of quality between PD-IVU and NPD-IVU examinations. For PD-IVU, the clinical questions were only partially answered for 10% of patients and were not answered for 2%. This is comparable with the NPD-IVU examinations, in which the clinical questions were only partially answered for 11% of patients which the clinically questions are partially answered and were not answered for 2%. This indicates that there is no degradation in the quality of the investigation and the PD-IVU examination was acceptable to the clinicians.

Since the introduction of PD-IVU, radiologists can now report 10 IVU examinations in the morning session and 7 in the afternoon session, compared with 6 in the morning and 4 in the afternoon previously. Although a radiologist is available in the event of a medical emergency, the radiologist will also be working a session unless there is an emergency call. Therefore, the standby radiologist is not included in the final estimated cost. The final estimated cost of each examination was reduced by 27%, with the major difference coming from the radiologist's salary.

The productivity of IVU examination can be increased by 70% because it is now possible to report 85 IVU examinations in 5 working days. Moreover, the IVU reporting can be grouped together to allow more flexible allocation of the work in the department.

Using this model, the manpower required for IVU examination decreased by 40% and the manpower saved could be deployed to other more value-added services such as magnetic resonance imaging or CT to enhance the productivity of the department. Since the implementation of the PD-IVU examinations, the overall waiting time for North District Hospital and Nethersole Hospital have decreased by 10 months to 2 months. This system safely maintained the quality of examination.

Interestingly, there was no significant difference in the overall time for the investigation. This means that there was no decrease in the length of time for the investigation even with a radiologist present. Although fewer films were used for NPD-IVU, the radiologists still need to review the films and make a further decision, which increases the time for the examination.

The safety of the PD-IVU examinations were also studied. None of these 200 patients experienced anaphylactic shock or other side-effects (only non-ionic water soluble contrast was used) such as skin rash or vomiting, and there was no extravasation of contrast when given by a radiographer. The examination is safe since the intravenous contrast used is non-ionic and the anaphylactic reaction tends to be lower than 1:40000. Although there is a small risk of drug allergy, a standby radiologist is working nearby and resuscitation can be quickly and easily implemented. All venous punctures are performed by radiographers who undergo a comprehensive intravenous access training programme before performing PD-IVU examinations. Apart from this intravenous access course, there is also a resuscitation programme and intravenous urogram programme for the radiographers to attend. As a result, the safety of patients is maintained when this protocol is implemented. The acceptance of patients is good and all accept having intravenous access and contrast injection done by the radiographer. No spoken or written complaints have been received so far.

There was a statistically significant difference between the 2 methods in the consumption of films with an average of 2 more films used for the PD-IVU method, indicating that the radiation dose to the patient may be slightly increased. Furthermore, further oblique and erect films are not included in the protocol and these are done according to the judgement of the radiographer, who has to decide whether further views are needed for evaluation.

The average reporting time increased from 1 to 2 days to approximately 10 days. This increase in reporting time is mainly due to the time used to redistribute the films and wait for the next IVU reporting session. However, delay in this setting is still acceptable as only elective non-emergency patients are included. There was no delay to the follow-up consultation.

CONCLUSION

PD-IVU is a safe and effective model for enhancing the cost-effectiveness of delivering IVU services while maintaining quality.

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