Utilization of Low-Dose CT for Urinary Tract Stone CT

Primary Authors: Mark E. Baker, MD
James H. Ellis, MD
C. Daniel Johnson, MD

Purpose and Rationale

This project aims to reduce the total radiation dose delivered to the population of patients receiving urinary tract stone CT ("stone CTs").

Evidence suggests low-dose stone CT may be as efficacious as standard-dose stone CT in the detection of most urinary tract calculi and extraurinary abnormalities. Alternatively, when a stone CT is required for follow-up imaging of known urinary tract stone disease, this follow-up stone CT can be obtained with a substantially lower dose than is typically used for the initial evaluation, when the diagnosis is not known.

> COMMENT: This project can have several variants. For example, the institutional guideline might suggest that follow-up stone CTs be diverted to MR or to Ultrasound (for obstruction) rather than to low-dose stone CT. Or the guideline may call for weight-based dose settings.
>
> Also required is the ability to identify which examinations are stone CTs and to determine whether these examinations utilized low or standard dose technique. These details can be performed by radiologists or other institutional personnel. Radiologists are expected to direct (though not necessarily intimately perform) the interventions that may be used.
>
> Finally, it is necessary to know for certain that a "low-dose" stone CT in the institution under study is in fact lower in dose than a standard CT. For example, for complex CT protocols that include automatic dose adjustment, the scanner may override what appears to be a lower dose setting on the scanner.

Resources

Ciaschini MW, Remer EM, Baker ME, Lieber M, Herts BR. Urinary calculi: radiation dose reduction of 50% and 75% at CT--effect on sensitivity. Radiology. 2009 Apr;251(1):105-11.

Thomas C, Patschan O, Ketelsen D, Tsiflikas I, Reimann A, Brodoefel H, Buchgeister M, Nagele U, Stenzl A, Claussen C, Kopp A, Heuschmid M, Schlemmer HP. Dual-energy CT for the characterization of urinary calculi: In vitro and in vivo evaluation of a low-dose scanning protocol. Eur Radiol. 2009 Jun;19(6):1553-9.

Karmazyn B, Frush DP, Applegate KE, Maxfield C, Cohen MD, Jones RP. CT with a computer-simulated dose reduction technique for detection of pediatric nephroureterolithiasis: comparison of standard and reduced radiation doses. AJR Am J Roentgenol. 2009 Jan;192(1):143-9.

Poletti PA, Platon A, Rutschmann OT, Schmidlin FR, Iselin CE, Becker CD. Low-dose versus standard-dose CT protocol in patients with clinically suspected renal colic. AJR Am J Roentgenol. 2007 Apr;188(4):927-33.

Local Resource

This project requires an existing institutional guideline / protocol on use of low-dose CT examinations for stone CTs (generally one in which low dose is recommended for some, but not all, stone CTs).

Measure

$$\text{Numerator} \quad \underline{\text{Number of Stone CTs that are performed consistent with the guideline}}$$
$$\text{Denominator} \quad \text{Number of Stone CTs performed}$$

* Include standard-dose stone CTs eligible for low-dose technique that have a validated exception (if any such exceptions for use of low-dose technique are noted in the institutional guideline).

* Exclude stone CTs done with low-dose technique that by guideline should have used standard-dose technique.

Collecting Baseline Data

Select a sampling strategy. Depending on the number of stone CTs performed within your institution, this might require a 100% audit or a smaller percentage of cases randomly chosen (for example, every third such case). Depending on the source of examinations ordered (e.g., Emergency Department, Urology, inpatients, outpatient clinics), it will likely be of value to obtain data over an extended period of time.

The number of cases needed will depend in part on the number of cases in which the guideline is not followed. If this is a substantial number of cases (e.g., 25%), then a baseline rate may be reasonably approximated by 50-100 cases.

If review of these cases reveals a very low rate of non-compliance (e.g., 1%), then it may take several hundred cases to estimate the current rate (and it may also show limited room for improvement, suggesting this may not be a good PQI project for your institution).

Assign one or more individuals to review the cases. Based on the history and indications, categorize the cases as guideline compliant or guideline non-compliant. For those found to be non-compliant, note the direction of non-compliance (e.g., low dose technique used when guideline calls for standard dose, use of standard dose when guideline calls for low dose, etc.). This may require a review of the radiology report (if dose data is included in reports), CT logbooks, review of dose data included in the images stored on PACS or photographed on film, or other information source that is available within the institution.

Baseline Data Analysis

Calculate the percentage of cases that were guideline compliant. Then analyze the patterns in any deviations noted. It may be useful to analyze the data in aggregate and by individual radiologist, if numbers allow.

After analyzing the baseline data, determine where there is room for improvement and select an improvement goal. This could be a fixed number (e.g., no more than 10 non-compliant cases per study period) or a fraction (e.g., reduce failure rate by half). Eventually--after one or more cycles-- the goal is a failure rate of 0% (allowing for documentation of validated exceptions).

Factors that Can Influence Performance

Examine the cases categorized as inappropriate to identify any patterns of contributing factors. Reflect on your setting and practice, and identify factors that may have influenced your results. Questions to consider include:

- Who in the institution is making the decision whether to employ low-dose or standard-dose technique?
- Is there sufficient access to required patient data required to apply the institutional guideline? For example: if the guideline calls for follow-up stone CTs to use low-dose technique, there must be a way to determine if this is the patient's first, or subsequent, stone CT.
- How easy is it to institute a low-dose stone CT (e.g., can technologists simply select a low-dose protocol on the scanner menu, or must they manually adjust the standard-dose protocol)?
- Assuming that someone other than the technologist makes the decision to use low-dose technique, what is the method of communication to the technologist that low-dose technique should be used?

Design an intervention to address these factors in your institution. In selecting an intervention, pick one to implement that you think has the best likelihood of positive effect. Select one intervention in each study cycle. Possible interventions might include:

- Collaborate with referring departments to increase awareness of and comfort with the institutional guidelines for use of low-dose stone CT technique.
- Develop an improved procedure for determining if an examination is eligible for low-dose technique according to institutional guidelines (e.g., easier access to or routine consultation of the Radiology Information System to review the patient's prior radiology examinations).
- Conduct educational programs for radiologists and technologists, and for others who may be making the decision to obtain low-dose vs. standard-dose stone CT.
- Require checklists for completion prior to performing stone CT.
- Produce an d disseminate weekly or monthly reports showing the number of low-dose stone CTs obtained vs. number eligible for low-dose.

- Improve labeling of examinations in the Radiology Information System (e.g., differentiate stone CTs from standard abdomen CTs to make it easier to apply the institutional guidelines)

Post-Intervention Data Collection and Analysis

Plan to collect data again at a set interval after the intervention, and then at specified intervals thereafter for the duration of the project (one to three years is typical).

Make sure that cases are collected, tallies are performed and metrics are analyzed the same way as at baseline. The only exceptions to this would be to adjust the number of cases collected if more cases are needed for analysis or to correct a problem identified with the baseline data collection procedure. If so, once the procedure has been corrected use it consistently going forward.

Data should continue to be collected over time. If improvement is continuing, the same intervals for data collection should be recommended. As improvement plateaus the interval for measuring and the number of exams that are measured can be reduced—as long as the metrics are stable. If a significant decrease in performance is seen, the project should start anew with analysis as to cause and potential fix.

It may prove necessary to assign cases without appropriate use of low-dose technique to individual decision-makers. If progress slows, it may be because the adopters are acting at best practice levels, but some outliers are not participating fully. Therefore it may be necessary to direct correctional efforts toward an individual, in addition to or in lieu of an institutional approach.

You may want to make a chart or graph of your performance over time to identify trends and patterns. Review the data with your project team after every data collection period.

If you are meeting your goals, no further changes may be necessary. However, you should plan to take steps to institutionalize whatever changes contributed to successful performance. If additional improvement is possible, look at your processes again and design additional interventions. It is generally best to only make one intervention per study cycle so that conclusions can be drawn about what caused the observed effect.

An excellent corollary to the project is to indicate the approximate total dose of radiation reduced per average patient over a given time period. This requires an assessment of the difference in radiation dose between a standard-dose and low-dose CT, and also an estimate of the number of low-dose-eligible stone CTs performed on the average patient over the given time period.