Mal-positioned nasogastric feeding tubes: Are medical students safe to identify them?

Running head : NGT Med Stu

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Declaration of competing interests: None.

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15 August 2023

Dear Dr Jackson,

We wish to submit an original research article entitled "**Mal-positioned nasogastric feeding tubes: Are medical students safe to identify them?**" for consideration by British Journal of Radiology.

We confirm that this work is original and has not been published nor is it currently under consideration for publication elsewhere.

In this paper, we report the results of senior medical students' ability to identify the safe placement of feeding nasogastric tubes (NGT) on chest xray. We also evaluated if their ability improved after using a bespoke online learning resource.

The rate of nasogastric feeding is rising globally. Although rare, great patient harm including death, could arise from the use of a misplaced tube. In the United Kingdom (UK), feeding down a misplaced NGT is classified as a preventable and reportable "never event" – with a rising incidence over recent years. Checking the NGT position on chest xray is one of a number of mitigating safety processes to prevent this iatrogenic complication. Non-radiologist clinicians could potentially initiate feeding through these tubes before formal radiology reports are available. Whether such clinicians received formal training and their competence at reading these examinations is uncertain. This is not a skill that can easily be learnt from attending a lecture. Radiology footprint in the undergraduate medical curriculum is small, resulting in a potential unmet need in medical students' education and a patient safety issue.

A free online learning resource was developed to meet this need for medical students at one of the largest medical schools in the UK. Our study evaluated the ability of graduating students to recognize misplaced NGT - before and after using the learning resource.

We think the wide readership of British Journal of Radiology will find this paper an interesting read and hopefully spark debate on how we can better deal with this patient safety issue. Together, we can explore ways to contribute towards educating tomorrow's clinicians while improving patient safety.

We have no conflicts of interest to disclose.

Please address all correspondence concerning this manuscript to myself at cindy.chew@glasgow.ac.uk. Thank you for your consideration of this manuscript.

Sincerely,

Cindy (On behalf of the Authors)

Abstract

Objectives

Nasogastric tube (NGT) placement is listed against Clinical Imaging in the upcoming Medical Licensing Assessment – compulsory for every graduating UK medical student from 2025. This study aims to establish the ability of medical students to correctly identify the position of an NGT on Chest Xray (CXR) and to evaluate a learning tool to improve student outcome in this area.

Materials and Methods

Fourth (MB4) and Fifth-year (MB5) medical students were invited to view 20 CXRs with 14 correctly sited and 6 mal-positioned NGT. MB5 students (Intervention) were exposed to an online interactive learning tool, with MB4 students kept as control. One week later, both groups of students were invited to view 20 more CXRs for NGT placement.

Results

Only 12 (4.8%) of 249 MB5 students and 5 (3.1%) of 161 MB4 students correctly identified all the NGTs on CXRs. The number of students misidentifying 1 or more mal-position NGT as "safe to feed" was 129 (51.8%) for MB5 and 76 (47.2%) for MB4 students. This improved significantly ($p<0.001$) following exposure to the learning tool with 58% scoring all CXRs correctly while 28% scored 1 or more mal-positioned NGT incorrectly. Students struggled to determine if the NGT tip had adequately passed into the stomach. However, they failed to identify an NG tube in the lung ("Never event") in just one out of 1,108 opportunities.

Conclusion

Medical students' ability to determine if the NGT was in the stomach remains suboptimal despite exposure to over 60 CXRs. Feeding NGT should be formally reported before use.

Advances in Knowledge

This is the first attempt at quantifying graduating medical students', and by inference junior doctors', competence in safely identifying misplaced nasogastric feeding tubes.

An online, experiential learning resource significantly improved their ability.

Keywords: nasogastric tube; medical students; safety.

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Introduction

Almost 1 million nasogastric tubes (NGTs) are purchased in the United Kingdom by the National Health Services (NHS) annually[1]. The global market for enteral feeding estimated at US$2.5 billion in 2022 is projected to reach US$4.1 billion by 2030[2]. Misplacement of nasogastric (NG) feeding tubes into the lungs leads to ongoing avoidable complications and deaths despite more than a decade since it was classified as a "Never Event"[3,4]. There have been multiple NHS Alerts since 2005 and worryingly, the latest reports suggest a rising incidence of these events[4-7]. While most NGTs are inserted and used without event, check chest X-rays (CXRs) to ensure correct tube placement are common. These show that around 1 in 50 are in the lungs while over 25% are unsafe for feeding[8].

Research has shown Radiology has a very small footprint in the medical school curriculum. Many medical schools do not have Radiologists on staff[9]. NG tube is 1 of only 2 (Trauma) presentations listed against Clinical Imaging in the General Medical Council's Content Map for the upcoming, compulsory, Medical Licensing Assessment for every graduating UK medical student (2025)[10]. It is unclear if medical students are routinely and systematically taught how to interpret NGT positions on CXRs; who is responsible for teaching this or if their competence in this important skill is assessed before they graduate. There is an urgent need to address this potential knowledge gap and patient safety issue.

The aims of this study were to:

(1) Establish the ability of Medical Students to correctly identify the position of an NGT on CXR;
(2) Evaluate the effectiveness of an online learning tool in improving medical students' ability to correctly identify the position of the NGT on CXR.

Materials and Methods

Learning Tool:

An online interactive learning tool was developed using Articulate® Storyline. This comprised:

(1) A teaching module, including relevant CXR anatomy and the "4 points method" of recognising a correctly placed NGT on CXR.

(2) Two sets of 20 CXRs (40 unique CXRs in total), self-assessment quizzes with feedback. For each CXR, students were asked if the NG feeding tube was correctly positioned (Yes/No). Immediate feedback was provided after each response with the correct answer and explanation. This resource is available online and is free to access now (https://www.thestudentradiologist.co.uk/ng-tube-module/). All CXRs included are fully anonymised.

Evaluation of students' ability to identify the position of feeding NGT on CXR

The Tests:

Two online tests (Test 1 and 2) were created using Google© Forms. Both tests contained the same 20-CXR images of NGTs, comprising 14 correctly sited and 6 mal-position NGTs, differing only by the sequence of the CXRs (n = 40). The tips of 4 mal-positioned NGT were in the oesophagus while 2 were in the lung ("Never Events"). The CXRs used in the evaluation tests were distinct from those used in the previously described learning module and self-assessment quizzes. Therefore students who completed the online learning module and two tests viewed 80 NGT CXRs in total (60 of which were unique). All CXRs were included after independent review by two senior radiology consultants of over 10 years' experience each.

Participants:

All students had previously undergone dedicated teaching on NGT insertion and how to evaluate NGT position on CXR. The manner in which students were tested and intervention applied is shown in Figure 1. Briefly, Fourth- (MB4) and Fifth-year (MB5) students from a single medical school were invited to attempt Test 1 while attending unrelated Radiology teaching in April 2023. The students were given time at the start of their respective lectures to attempt Test 1.

MB5 student had recently sat their final medical school assessments and formed the intervention group, receiving the link to the online training tool after attempting Test 1. They were given one week to access the learning resource and then invited via email from the medical school administrator to attempt Test 2. Students' responses were collected after a further week, with one reminder email sent during that period. The MB4 students formed the control group and were invited to complete Test 2 a week after attempting test 1, without any interval teaching intervention. Interval between the 2 Tests is the same as MB5. The link to the learning tool was shared with MB4 students after Test 2 closed, allowing them to access the online resource at the end of the study.

NGT CXR interpretation ability: Students' self-rated confidence

All respondents were asked:

(i) to rate their confidence in their ability to correctly identify the position of a feeding NG tube on a 5-point Likert scale (1-not confident; 5 – very confident) and

(ii) if they would like more teaching / resources on how to read CXR for feeding tube placements.

Responses were collated and students performance (scores) were evaluated. Paired responses for students who attempted both quizzes were matched and anonymised before evaluation.

Participation was voluntary. A small raffle prize was offered to encourage uptake; participation in the raffle was optional.

Statistics:

Data is expressed as mean with standard deviation or mean with 95% confidence interval (C.I.) where appropriate. Differences in the number of NGT CXRs correctly identified between control and intervention groups was assessed using a two sample t-test. Analyses were performed using Minitab LLC (version 18) at a 5% significance level.

Institutional Review Board approval was sought but waived, as this was deemed a quality improvement exercise, part of expected teaching practice. All CXRs were anonymised.

Results

Two hundred seventy-seven MB5 and 207 MB4 medical students attended the unrelated, scheduled online Radiology teaching sessions in April 2023. Two hundred forty-nine (90.0%) MB5 and 161 (77.8%) MB4 students completed Test 1.

Only 12 (4.8%) MB5 and 5 (3.1%) MB4 medical students correctly identified all the NGT positions on CXR in Test 1. The number of students misidentifying 1 or more of the 6 mal-positioned NG tubes was 129 (51.8%) for MB5 and 76 (47.2%) for MB4 students. There was no significant difference in the outcome for either events between the groups (Table 1). Most students did not recognise 1 mal-positioned NGT while 23.4% misidentified 2 and 3.9% - 3.

Outcome Intervention Group: Final Year Medical Students (MB5)

Following the online teaching module, 81 (32.5%) students repeated the test (Test 2), of which pre- and post-intervention scores were matched for 79. There was a significant improvement in both the number of students who correctly identied all 20 NGT positions and those who correctly recognised all malpositioned NG tubes ($p<0.001$) – Table 2.

Outcome Control Group: Fourth Year Medical Students (MB4)

Seventy-one MB4 students completed Test 2, of which 63 (39.1%) were matched to their to Test 1 scores. There was no improvement in the overall scores from Test 1 for this group of students (Table 3). This includes those who correctly identified all the mal-positioned NGT CXRs.

Overall, the improvement in the mean number of NGT correctly identified on CXR for the intervention group (MB5) was 2.8, compared to 0.59 in the control group ($p<0.001$). The change in scores post intervention was 2.21 higher in the intervention group than in the control group (Figure 2).

Identification of Never events

In each test there were 2 CXRs with NGTs mal-positioned within the lungs. Therefore across the whole student participant group there were 1,108 opportunities to recognise a feeding NGT CXR "never event". Only 1 NGT CXR "never event" was incorrectly interpreted as being safe to use for feeding (0.0009%).

The most commonly misidentified NGT position was on a CXR where the tip of the NGT was located within distal oesophagus (near the oesophagogastric junction) – Figure 3A. Identification of this NGT CXR did not improve after the learning tool, despite at least 5 similar NGT CXR practice examples with explanation and feedback about why these tubes were not appropriately sited for feeding.

NGT CXR ability : Self-rated confidence (Likert scale)

Of the final year medical students who did not recognise the mal-positioned feeding tubes in Test 2 (post intervention), 81% rated their confidence as 4 or 5 on a 5-point Likert scale (5 being "very confident"). This compared to 70% of MB4 students in the same situation rating their confidence as just 2 or 3. All but 7 (95.7%) of the MB4 students expressed a desire for more teaching on correctly identifying feeding NG tube position.

Student Feedback

"*The online resources were very very very helpful! One of the best tools in my time at university. I feel a lot more confident in assessing NG position on CXR now. Really liked (sic) there was a magnifying glass option for a couple of the tricky ones." – MB5 Student*

Seventy-one (87.7%) free text comments were received from the MB5 cohort. Students found the learning tool easy to use and provided good practice (Appendix 1). They particularly liked the clear and concise presentation, annotation, various embedded interactive tools (e.g. magnifying glass) and having multiple examples to try with feedback to consolidate their learning. There were 2 comments relating to the timing of this intervention ("too close to the exams" and "could have been done at the time of the teaching").

Discussion

This study shows that Fourth and Fifth year medical students were excellent at recognising a mal-positioned feeding NG tube in the lung on CXR. This is important because as Foundation Doctors, they may be the first to interpret a CXR in a patient whose NG tube aspirate is suboptimal. The students' ability to determine if the tip of the NG tube has passed the oesophagogastric junction and into the stomach was unsatisfactory however. Although this was significantly improved following exposure to the online teaching/testing module, the effect was not enough to allow reliable interpretation of NG tube position by junior staff.

It is perhaps not surprising that medical students had difficulty recognising that the NGT had passed the oesophago-gastric junction (OGJ) into the stomach on CXR. This correlates with the performance of trained radiographers[11]. The OGJ is invisible on Xray and the observer is relying on the position of the central portion of the left hemidiaphragm to tell if the NGT has passed at least 5-10cm beyond this. In real life acute situations, this can be even more challenging from suboptimal patient positioning or radiographic quality. In this study, students were exposed to CXRs of higher image quality than average, chosen by ~~an~~ experienced radiologists. It is likely therefore our results reflect the best outcome that can be observed with senior medical students assessing the CXRs.

A recent study assessing artificial neural network ability to recognise mal-positioned NG tube on CXR confirms the poor performance of junior doctors in this area[12]. These doctors with a minimum of 2 years post qualification from medical school had an area under the curve agreement of just 0.53 when compared with consultant radiologists. Moreover, of the 25 mal-positioned bronchial NG tubes, they interpreted 5 as being safe for feeding. It is not known if any of these junior doctors had formal training in recognising complications from NG tube placements before or after graduating from medical school.

Of concern was the high proportion of students (94%), with at least 1 wrong response to a mal-positioned feeding tubes, that rated their confidence in identifying NGT positions as 4 or 5 out

of a 5-point Likert scale (5 = very confident). These highly confident final year graduating medical students (MB5) were unaware of their limitations. This could potentially explain why junior clinicians may not ask for help as often as one might expect or they should. This contrasts with the majority of MB4 students who expressed lower levels of confidence in their ability to correctly categorise feeding NG tube positions, even though they received their formal teaching on the topic more recently.

A position paper by British Association for Parenteral and Enteral Nutrition (BAPEN) reminds us that nasogastric feeding tube insertion is not a "simple" procedure[5]. It is instead, a "complex" and dangerous procedure and confirming its position for use should be limited to properly trained and competent healthcare professionals. Misplacement and use of intra-pulmonary nasogastric feeding tubes leads to ongoing avoidable complications and deaths, classified as Never Events. It is a reportable incident and the most common cause for using misplaced NG feeding tubes relates to the use of X-rays to confirm intra-gastric placement[8, 13-15]. Despite multiple NHS Alerts since 2005, there is concern about the upward trend of such events. This despite a freely available guide on how to read CXRs for feeding tubes produced by the Society of Radiographers since 2012 (no longer available), leading to a Healthcare Safety Investigation (2019/2020) [1,16]. One of its conclusions was the need for better education of staff involved in feeding tube placement while also highlighting the barriers to staff education, limits to "standardised accreditation" to improving safety and the not insignificant time it would take to implement all its commendations. A recent review found wide variation in the clinical practices and adherence to the UK national guidance related to the placement and position confirmation of adult nasogastric feeding tubes[14]. Radiographer reporting / commenting is in place for many Health Boards / Trusts to improve safety and reduce delay [11,17]. However, radiographer training (eg 1 hour face to face group teaching or 10 NGT CXR tests) is non-standardised and accreditation information lacking. The decision to use the NGT for feeding remains firmly with the clinician on the ward. Simulation was listed in the Health Services Safety Investigations Body (HSIB) report as a potential educational solution. Our study exposed students to 60 NGT CXRs and is a defacto "simulation" experiential learning exercise for students in a safe space to decide if the NGT was positioned safely for feeding.

Reflecting on the HSIB report and acknowledging the limitations of human factors, it may not be possible to ever completely prevent feeding down a NG tube sited in the lung[11,18-20]. However, many safety interventions can be put in place – including our learning module for medical students. The HSIB report mentioned the potential benefit of accrediting only a specific staff group (reporting radiographers or radiologists) for evaluating the CXRs prior to initiation of feed. Detailed psychometric input will be required to ensure any certification or credentialing assessment is defensible in this high stakes scenario. Systemic processes are repeatedly raised as a key factor in safety recommendations[14].

Given the results of our study, Health Boards, Senior Clinicians and Radiologists need to work together urgently to find interim solutions suitable for deployment now. This could potentially include mandating all CXRs performed for the purpose of confirming NGT tip position require verified radiology reports prior to initiation of feeds.

Strengths of this study

This is the first study to attempt to assess (final year) medical students' ability and competence to correctly identify a mal-positioned feeding NG tube. The use of a control group helped to quantify more accurately the effectiveness of our new learning tool.

Potential limitations

The response rate of Test 2 for MB5 student was just 32.5%. This may be related to the timing of our study occurring just a week after Final exams - students were understandably tired and fatigued. It could also potentially introduce a degree of "self-selection bias" of a more motivated student volunteer population in this study. Nonetheless, this rate was thought comparable to general survey response rates and at 81, was thought adequately robust. Another potential limitation was how CXRs images are presented in the online tests. While not of radiology reporting workstation DICOM image quality, these TIFF images were thought reflective of the quality of images ordinarily encountered by clinicians viewing radiological images on ward computer screens. Finally, lack of access to a measuring tool during the tests

could have potentially limited students' ability to correctly recognise and partly explain their struggle to identify when the NGT tip is (not) adequately past the OGJ.

Conclusion

Medical students are poor at identifying misplaced feeding tubes on chest X-rays. While our medical students were excellent at identifying misplaced NG feeding tubes in the lungs, their ability to determine if the tip had passed through the oesophagogastric junction into the stomach was suboptimal. Our learning tool was effective in improving their performance but could not completely prevent mis-identification of all mal-positioned feeding tubes. More robust systems-level solutions are required to improve patient safety and consideration should be given for all feeding NG tubes to be formally reported before commencing feed.

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Figure captions

Figure 1. Summary of study outline

Figure 2. Total CXRs identified correctly for Test 1 and 2 for MB 4 and MB5 students

Figure 3: CXR which students struggled to recognise the NGT tip is not within the stomach (A); one of the CXR with NGT in the lung (B)

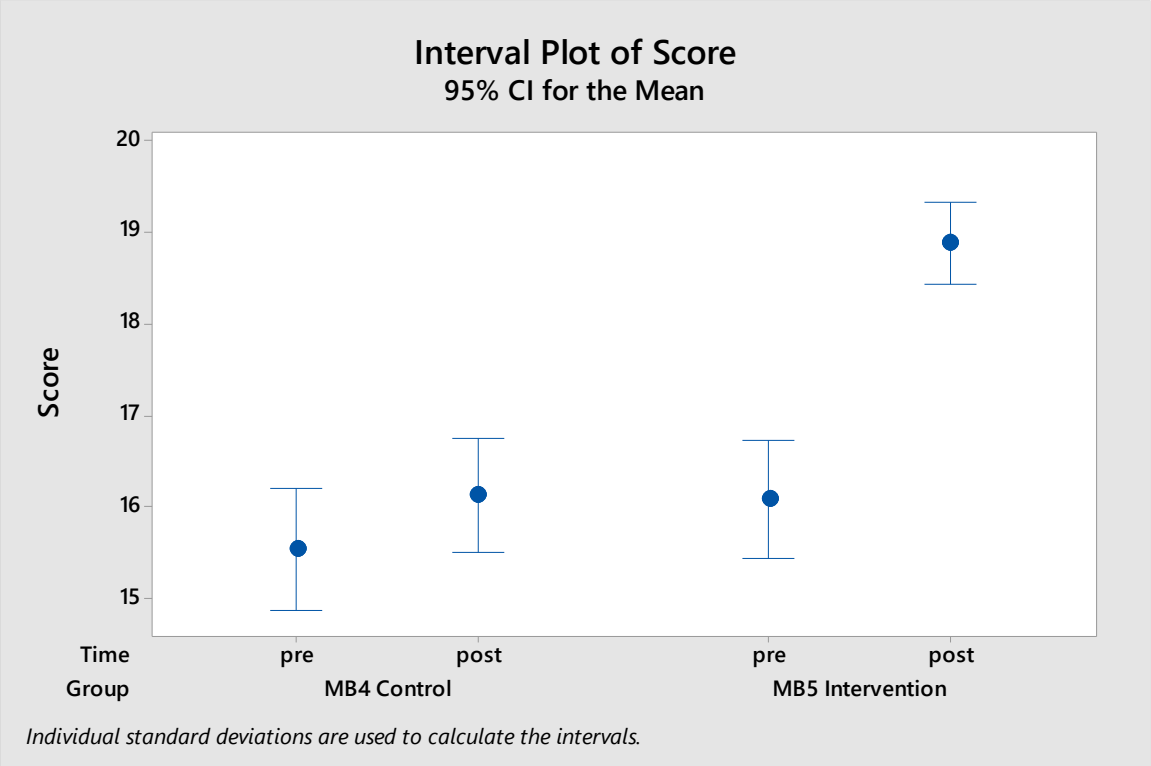
Tables:

Table 1. Baseline results for Control (MB 4) and Intervention (MB 5) Groups

Table 2. Intervention Group (MB 5) - Matched Tests 1 and 2 results.

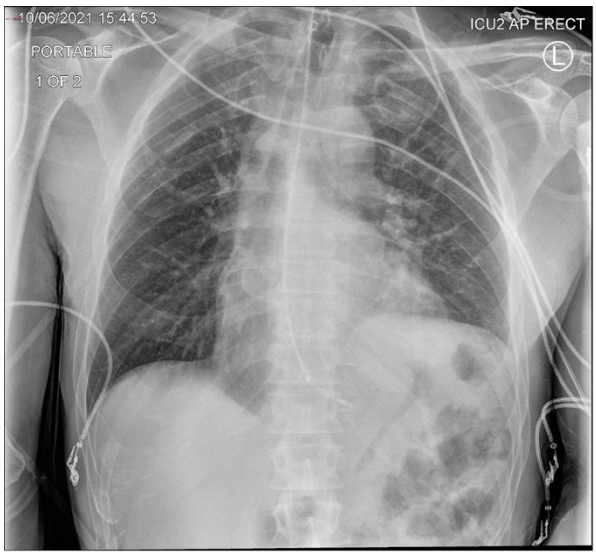
Table 3. Control Group (MB 4) - Matched Tests 1 and 2 results.

Figure 2 : Total CXRs identified correctly for Test 1 and 2 for MB 4 and MB5 students



CI: Confidence interval

Figure 3: CXR which students struggled to recognise the NGT tip is not within the stomach (A); one of the CXR with NGT in the lung (B).



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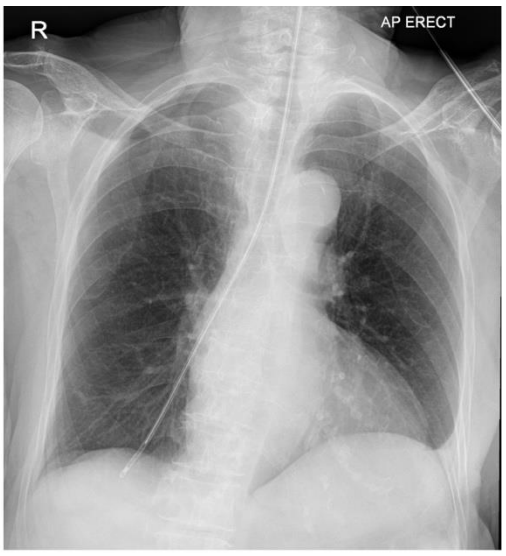

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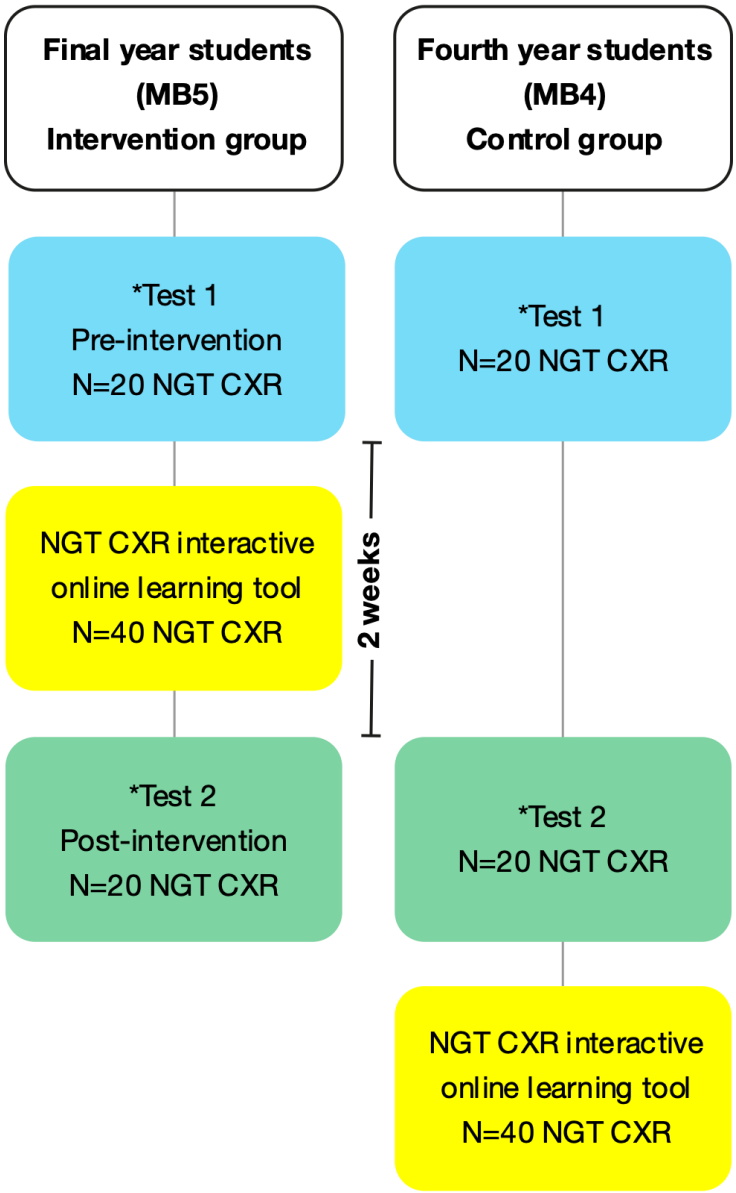
Figure 1: Summary of study outline.



*Test 1 and 2: Same 20 NGT CXRs but sequence in order were changed.

Table 1 : Baseline results for Control (MB 4) and Intervention (MB 5) Groups

	Control Group N=161 (%)	Intervention Group N=249 (%)
No. students scoring all NG tube CXRs correct	5 (3.1)	12 (4.8)
No. students scoring 1 or more malpositioned NG tube CXRs incorrectly	76 (47.2)	129 (51.8)

Table 2: Intervention Group (MB 5)- Matched Tests 1 and 2 results (N = 79)

	Test 1 (%)	**Test 2 (%)**
No. students scoring all NG tube CXRs correct	6 (7.6)	46 (58.2)
No. students scoring 1 or more malpositioned NG tube CXRs incorrectly	41 (51.9)	22 (27.8)

Table 3 : Control Group (MB 4) - Matched Tests 1 and 2 results (N = 63)

	Test 1 (%)	Test 2 (%)
No. students scoring all NG tube CXRs correct	3 (4.8)	1 (1.6)
No. students scoring 1 or more malpositioned NG tube CXRs incorrectly	24 (38.1)	26 (41.3)

Appendix:

Students' free text comments (N=71, 87.7%)

Comments	Number (71 responses)
"very good", "great", "excellent"	**28**
"very useful"	**21**
"very helpful"	**13**
"practice", "lots of examples"	**12**
"very easy to use", "liked"	**11**
"more confident"	**7**