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Bridging the gap: a simulation-based education programme to improve the management of postoperative neck haematomas

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ABSTRACT

Introduction:
Postoperative neck haematomas have a reported incidence of 3.4%. They result in a longer length of hospital stay, higher costs and a higher mortality rate. Consensus guidelines provide an algorithm for the management of a suspected neck haematoma and recommend that staff are trained to recognise the symptoms and signs of a neck haematoma. They also suggest the introduction of a post thyroid surgery emergency box. Our aims were to provide education in the form of simulation scenarios and to introduce a neck haematoma evacuation box.

Methods:
This quality improvement project was carried out in a large tertiary referral hospital, with over 1000 beds. It is the major head and neck surgical centre in Ireland. Ethical approval was granted by the hospital. Four simulation training sessions were carried out with Ear, Nose and Throat (ENT) nurses and interns. Voluntary surveys were conducted before and after the sessions. A sample neck haematoma evacuation box was used for the simulation scenarios.

Results:
50 staff participated in simulation training. 7% of staff had seen a neck being evacuated on the ward. 37% had received prior teaching on the management of neck haematomas. Significantly more participants reported to know the symptoms and signs of a neck haematoma and the required management of a neck haematoma after completion of the simulation sessions. All participants agreed neck haematoma evacuation boxes were necessary and would improve patient outcomes.

Discussion:
The pre-simulation survey demonstrated that an unacceptably low amount of staff had previous training on this topic. Simulation training resulted in more participants being able to identify the signs and symptoms of a neck haematoma and more participants feeling confident regarding the necessary actions. The results show the positive impact of simulation training and provide a basis for advocating for this training to continue on a regular basis. Simulation works to increase participants confidence and familiarity with a given situation. Simulation training also improves technical skills and teamwork. There was unanimous support for the introduction of the post neck surgery haematoma evacuation boxes, which suggests that these would be a valuable introduction in our hospital.

What this study adds:

- Demonstrates the provision of education on neck haematoma management through the use of high-fidelity simulation.
- Details the successful introduction of a neck haematoma evacuation kit, as recommended by recent guidelines.
- Provides a template for simulation training of the management of a postoperative neck haematoma.

Introduction

Postoperative neck haematomas have a reported incidence of 2.4%–3.4% [1,2]. They have been described after thyroid, laryngeal, carotid and cervical spine surgery [1–4]. Postoperative neck haematomas carry significant patient morbidity and mortality; they often occur in the neck's deep fascial layers, which can make them difficult to identify at the bedside. Major airway compromise can result from direct compression by haematoma, impaired venous drainage in the region and concomitant airway oedema. Postoperative neck haematomas result in longer hospital stays, higher costs and a higher mortality rate [1]. The Difficult Airway Society, British Society of Endocrine and Thyroid Surgeons, and Ear Nose and Throat Surgery United Kingdom (ENT UK) published consensus guidelines providing an algorithm for the management of suspected neck haematoma following thyroid surgery. As part of their recommendations, they advise that all clinical staff interacting with these patients are trained to recognize the potential symptoms, signs and subsequent management [5]. The guidelines also suggest introducing a post-thyroid surgery haematoma evacuation kit for emergency use which should be immediately available at the patient's bedside. We believe such principles should be targeted towards post-thyroidectomy neck haematomas, but they can be broadly applied to other surgeries where there is a risk of a postoperative neck haematoma.

Simulation training has become a common form of clinical training in recent years. It is a valuable method of training as it allows trainees to gain exposure to clinical scenarios in a controlled and safe environment. Simulation training improves technical skills and teamwork [6,7]. It has also been shown to be effective for gaining surgical skills [8,9].

Our aims with this quality improvement process were two-fold. First, to provide education in the form of interprofessional simulation scenarios to all staff providing care to these patients on the otolaryngology surgical ward. The primary aim of this education programme was to improve participants' confidence and self-assessed competency to recognize the signs and symptoms of a postoperative neck haematoma and to ensure staff were aware of the appropriate escalation protocol in this emergency scenario. Our second aim was to introduce an emergency neck haematoma evacuation kit to accompany all patients who have had a thyroidectomy from the theatre recovery room to the ward and remain by the patient's bedside for their postoperative stay.

Table 1: Contents of neck evacuation kit

Contents of neck evacuation kit
Scalpel
Scissors
Sterile gauze
Artery clip
Management of suspected neck haematoma guidelines
SCOOP guideline (i.e. guideline with steps on how to evacuate the neck)

Methods

This quality improvement process was carried out in a high volume, tertiary referral, head and neck cancer centre, receiving 60%–70% of all referrals nationally. Institutional approval was sought and granted for the project.

We created a simulation scenario detailing learning objectives, necessary equipment and simulation staff, scenario development, patient behaviour, and suggested points for discussion at debrief (Appendix A). Simulation training scenarios were held on the otolaryngology (ENT) postoperative surgical ward and were led by a Consultant Anaesthetist with a special interest in complex airway

Figure 1: Manikin demonstrating haematoma between superficial and deep layers of sutures.

Table 2: Questions asked pre- and post-simulation training

Questions asked before and after simulation training	Pre-sim responses	Post-sim responses	*p* Value* (CI)
Do you know symptoms and signs of a neck haematoma?	38 (83%) Yes	50 (100%) Yes	0.002 [0.72–0.943]
Do you feel you know what to do if you think someone is developing a neck haematoma?	22 (48%) Yes	50 (100%) Yes	<0.001 [0.354–0.647]
Would you feel confident evacuating a neck haematoma if you had to yourself?	5 (11%) Yes	33 (67%) Yes	0.052 [0.110–1.040]

*Pearson chi square.

management and simulation training. The ward's Nurse Manager reviewed the questionnaire and scenario before the series of training sessions were commenced. A high-fidelity manikin (SimMan Essential, Laerdal Medical, Stavanger, Norway) was used for the scenario. Four simulation training sessions were performed over the course of 4 days, with nurses from the main ENT and maxillofacial postoperative surgical wards and surgical interns as participants. In total, 50 participants attended or took an active role in the simulation sessions. We carried out qualitative questionnaires before and after the sessions. These were developed with consideration of the learning objectives (Appendix A) and with the aim of the assessment of; training; experience; knowledge; familiarity with management; attitudes.

A brief was provided to participants explaining that they should treat the SimMan like a normal patient, apply monitors as they would for patients, assess and examine the SimMan and take actions like they would for any patient. A facilitator (Post Anaesthesia Care Unit nurse) would give their standard postoperative handover to the participant (ENT ward nurse) for a well post-thyroidectomy patient (see an example in 'Clinical Case Information' in Appendix A). The scenario progressed from evaluating a well patient to a clinical deterioration from an airway perspective. At this point, a neck haematoma was added to the SimMan (Figure 1). Participants were encouraged to follow the steps they would normally follow in this scenario including calling appropriate team members to review the patient. Surgical interns were called as active participants to review the patients and real-time calls were made to ENT surgeons performing their regular duties in other areas of the hospital. The brief was to manage the scenario as it evolved. Emergency neck haematoma boxes were provided for the scenarios along with the recently published guidelines [5]. Prompts were provided as required and the scenario was allowed to progress until an ENT or anaesthesiology registrar had arrived to evacuate the neck haematoma and organized safe transfer of the patient to theatre. When the simulation ended an overview of the case management and debriefing was carried out using the plus/delta approach discussing what was done well or could have been done differently. At this point, post-simulation questionnaires were filled out.

A sample neck evacuation kit was created and used for the simulation scenarios. This was created using a simple clear box and some equipment from theatre. The contents of this kit are listed in Table 1. An introduction to the scenario was given to participants and they were given the opportunity to ask questions and to examine the manikin and neck evacuation kit before the scenario began (Appendix A details the clinical case and 'scenario start' information which was provided).

Results

Pre-simulation questionnaire results

The questionnaires completed before the simulation training session showed that only 6.7% of staff had seen a neck being evacuated on the ward. 37% had received prior teaching on the management of neck haematomas. 83% felt they would recognize the signs and symptoms of a postoperative neck haematoma, but only half stated that they knew what action to take in this situation (Table 2). All respondents said they would be interested in attending a simulation training session.

Respondents were also asked about their attitudes towards introducing a post-neck surgery haematoma evacuation kit. 100% feel that introducing a neck haematoma evacuation kit is necessary, and all felt that the kit would improve patient outcomes.

Post-simulation questionnaire results

42% of participants were more than 5 years qualified as a nurse. 13% were doctors. 18% were less than 2 years qualified. 12% had between 2 and 5 years of experience. 2% were student nurses.

All participants agreed that they found the simulation beneficial. All participants said they would recognize the symptoms and signs of a postoperative neck haematoma and would know what action to take in this situation. 98% think they will be more aware of the possibility of someone developing a neck haematoma. 98% feel the simulation should be repeated. 98% said they would be interested in attending the simulation again if it was offered in six months. Some of the comments from the questionnaire included: 'it was beneficial to practice this scenario in a simulation'; 'I would like this sim to be repeated at 3 months or more frequently'; 'this sim should be mandatory for all interns - very useful'; and 'the suggestion to have neck evacuation boxes is very handy'.

Discussion

The incidence of Head and Neck Cancer (HNC) is rising annually, with a predicted 30% increase in the number of new cases by 2030 [10,11]. Therefore, we must provide

frequent formal training for staff on the management of potential complications of HNC surgery. This study shows that simulation training can significantly improve the confidence of healthcare staff in recognizing and implementing appropriate management of postoperative neck haematomas. This is important as it suggests that simulation training has the potential to improve clinical care.

The pre-simulation questionnaire demonstrated that only a small number of staff had previous experience with evacuating a neck haematoma. This was not surprising as we know it is uncommon, but it also reflects the attendance of more junior staff (interns) with less clinical experience. Only one-third had previous training on this topic, which is surprisingly low given the amount of head and neck surgery in the hospital.

The simulation training sessions resulted in more participants being able to identify the signs and symptoms of a neck haematoma and more participants feeling confident they know the necessary action required in this situation. Furthermore, four times as many respondents said they would feel confident evacuating the haematoma themselves if required, compared to responses before the simulation. These results show the positive impact of simulation training and provide a basis for advocating for this training to continue on a regular basis. Successful management of a neck haematoma after staff simulation training has been described in the literature [12].

This study provides insight into the attitudes of healthcare staff towards simulation training. It was clear from the responses given that healthcare staff feel insufficient time and resources are dedicated to providing efficient clinical professional development. Staff responded positively towards the training incorporated into this study. Another theme identified from responses was; the recognition of the deteriorating patient. Participants selected this as one of the most crucial aspects of education and the most satisfying for targeted improvement.

Our training demonstrates that simulation works to increase participants' confidence and familiarity with a given situation. Another study involving simulation with the use of a task trainer for evacuation of a retrobulbar haematoma also showed that simulation training acted to increase participants' confidence in management [13]. Simulation-based training is now well-established as a method for effective, high-yield teaching. Simulation-based training has been shown to be more effective than didactic teaching when teaching doctors how to deal with various acute patient scenarios [14,15]. As well as technical skills, a small RCT of simulation training for non-technical skills in crisis resource management has shown that the learning from the scenario was unchanged between active participants and observers [16].

'High-fidelity' simulators have been developed in recent years. This term has emerged from the need to distinguish between mannikins that contain more advanced technology and thus provide a greater degree of realism, to mannikins which do not provide any advanced features. This study involved a high-fidelity simulator, that is, a mannikin which is remotely controlled by a computer, or which can simulate patient noises or movements. However despite the increasing development, expense, and interest in high-fidelity mannikins, the literature suggests that low fidelity simulators are non-inferior to high-fidelity simulators, with one study even suggesting that high-fidelity simulators can lead to overconfidence among students [17,18].

Debriefing is a key part of the learning process in simulation [19,20]. We took a plus/delta approach to debriefing for this project. This method encourages the learner to reflect on one's own performance, as well as the overall team performance [21]. Learners are asked 'what went well', 'what did not go well and why', and 'would you do anything differently next time'. The plus/delta method promotes teams to reflect on their performance, which can enhance teamwork through shared models of thinking [22]. Thus, it felt appropriate for this scenario as it involved participants who work together on a team basis daily.

There was unanimous support for the introduction of the post-neck surgery haematoma evacuation kits, with all participants stating it could potentially improve patient outcomes. The need for the availability of emergency equipment at the bedside has been recommended and implemented for several different clinical scenarios. For example, it is common practice for patients with new tracheostomies to have an emergency tracheostomy kit at their bedside, as the National Tracheostomy Safety Project recommended [23].

This study has many strengths. It focused on the education of staff in an area of great importance and may help to reduce future patient morbidity and mortality. It involved pre- and post-simulation questionnaires allowing us to compare before and after. The second aspect of the study, the introduction of a neck haematoma evacuation kit, is supported by recently published guidelines [5]. However, there are also several limitations to our study. This was a single-centre study. It had a small number of participants. Finally, we have no evidence that this education will impact patient care.

We suggest that simulation-based training for this infrequent high-risk clinical scenario should occur at regular intervals to maintain staff competencies. A previous study which compared six weekly to six monthly repetitions of simulation, showed higher technical and non-technical scores in the 6-week group [24]. However, the frequency of simulation repetition must be balanced against the practicalities of providing this in a busy tertiary hospital environment.

We recommend that training on neck haematomas and their management should form part of a medical student's teaching in their final year and this training should be repeated during intern induction. Similarly, all doctors rotating through the ENT team and nurses working on post-op surgical wards should attend a simulation scenario on neck haematomas as part of the job. We recommend introducing neck haematoma evacuation kits as part of the postoperative plan for patients having any form of neck surgery. We believe these kits should accompany the patient from the recovery room to the ward and remain at the

patient's bedside until discharge. Future studies into which patients are more likely to develop a haematoma would be welcomed. This may allow patients to be risk stratified and their postoperative care location could be based on their risk.

In conclusion, we have demonstrated the introduction of emergency neck haematoma evacuation kits for all patients undergoing thyroidectomy and we successfully introduced a simulation teaching programme to assist staff in the management of this emergency scenario.

Declarations

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None declared.

Competing interests

None declared.

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Appendix A

Scenario:

Post-thyroidectomy neck haematoma

Target audience – scenario can be adapted to suit target audience:

- Student nurses and doctors.
- Staff nurses – PACU & surgical ward nurses.
- Hospital doctors including interns, SHOs & registrars in anaesthesia and ENT.

Goal of simulation:

- Recognition and appropriate management of a post-thyroidectomy neck haematoma
- Multi-disciplinary approach to scenario management

Learning objectives:

After this scenario, participants will be able to:

1. Recognise symptoms and signs suggestive of neck haematoma.
2. Communicate effectively with the patient to address and alleviate concerns.
3. Take appropriate action to manage patient's symptoms.
4. Escalate scenario to appropriate multi-disciplinary team.
5. Assemble emergency equipment.
6. Perform evacuation of neck haematoma (if appropriate).
7. Recognise need to transfer patient to theatre to secure airway and perform examination under anaesthesia to identify source of bleeding.
8. Plan for appropriate discharge location.

Expected duration of simulation:

- 10 minutes briefing time
- 15 minutes for scenario.
- 20 minutes for debrief.

Equipment required and set-up:

Depends on target audience.

a) **Clinical environment**

1. Theatre
2. Post-anaesthesia care unit or recovery room
3. Post-operative surgical ward

b) **Simulator**

- Manikin with head and torso e.g., Sim Man®

c) **Task trainer**

- ORSIM® - could be used for advanced scenario with anaesthetic registrars in theatre for simulated awake fibreoptic intubation.

d) **Equipment, consumables and props required:**

Monitoring

ECG, non-invasive blood pressure, pulse oximeter

Vascular Access

IVC x2

Drugs

- Emergency drugs – e.g. adrenaline, atropine, amiodarone, ephedrine, phenylephrine
- Anaesthetic drugs – Fentanyl, Propofol, Rocuronium
- Adjuncts – Dexamethasone, Tranexamic Acid
- Topical anaesthetic agents – 10% lidocaine spray, 2 or 4% lidocaine, co-phenylcaine spray

Fluids

1L Compound sodium lactate & giving set with injection port.

Airway equipment

- Oxygen mask, multiple venturi connectors for various 02 concentrations
- 100% non-rebreather mask
- Facemask – various sizes
- Guedel airways – various sizes
- Direct or video laryngoscope
- Tracheal tubes - various sizes & types e.g., re-inforced, microlaryngeal
- Larngeal mask airway – various sizes
- Nasendoscope or fibreoptic scope and monitor

Neck Haematoma Box

Contents as per joint consensus guidelines

- SCOOP algorithm
- Neck haematoma management algorithm
- Size 10 scalpel
- Staple remover
- Sterile scissors
- Sterile gauze
- Artery forceps
- Wound pad – 10cm x 20cm
- Sterile gloves

Consumables for neck haematoma (see image 1)

- Fake skins x2/3 – 1 for backing, 1 to form "strap muscles", 1 for skin.
- Jelly for simulated haematoma
- Suture – to close "strap muscles"
- Steri-strips to close skin incision
- Tape to attach haematoma to neck

Paperwork

- Anaesthetic record
- Operative note
- Observations chart
- Patient chart

Other

- Thromboembolic deterrent stockings
- Surgical gown
- Blanket
- Pillow
- Trolley

Simulation Staff

Depends on availability.

Technicians

1-2 technicians:
One required to run the manikin console.
One required to voice manikin.

Simulated participants:
Depends on the target audience.
1-2 to direct the simulation.

Debrief team/faculty members:
2 trained faculty members to run debrief.

Learner Prerequisites

Learners were expected to be familiar with basic ward equipment. They were also expected to recognise abnormal vital sign results.

Clinical Case Information

Patient Background

- 36-year-old female

Background:

- Total thyroidectomy for Grave's Disease

PMHx/PSHx:

- Asthma
- Right ACL repair
- Tonsillectomy

Anaesthetic History:

- Uneventful

Social History:

- Non-smoker, non-drinker
- Teacher
- Lives with partner

Medications:

- Salbutamol
- Flixotide

Allergies:

- NKDA

Airway Assessment:

- Mallampati 1
- Mouth opening > 3 finger breath

Triggers for scenario progression		
Time Point 1 - Recovery room nurse	**Time Point 2**	**Time Point 3 - ENT & anaesthesia registrars enter scenario**
Vital Signs **HR** - 70 **BP** - 110/65 **RR** - 14 **Sa02** - 98% **Fi02** - 40% venturi **Temp** - 36.6 **GCS** - 15	**Vital Signs** **HR** - 100 **BP** - 140/80 **RR** - 22 **Sa02** - 92% **Fi02** - 40% venturi **Temp** - 36.6 **GCS** - 15	**Vital Signs** **HR -** 120 Sinus tachycardia **BP** - 155/85 **RR** - 28 **Sa02** - 99% non-rebreather **-** 92% venturi 40% **Fi02 -** Depends on participants intervention. **Temp -** 36.6 **GCS -** 15
Clinical Assessment • Patient complains of difficulty swallowing and feels anxious. • Swelling noticed at incision site.	**Clinical Assessment** • Patient complains of feeling pressure in their neck and some difficulty breathing	**Clinical Assessment** • Patient has audible stridor
Trigger to proceed to time point 2 • Patient complaint and identification of neck swelling	**Trigger to proceed to time point 3** • Desaturation despite supplemental 02 • Patient complaint of difficulty breathing and sensation of pressure	
Expected Action of participant	**Expected Action of participant**	**Expected Action of participant**
• Sits patient up. • Calls for assessment by ENT team. • Repeats observations. • Raises concerns with PACU CNM.	• Applies higher 02 concentration. • Calls for review by anaesthetist. • Locates neck haematoma evacuation box. • Reviews and implements management algorithm as appropriate.	• Uses ISBAR to handover to ENT & anaesthetic team. • Requests difficult airway & arrest trolleys. • Points out availability of neck haematoma evacuation box. • Assists MDT during evacuation. • Reassures patient during procedure. • Plans move to theatre.

Figure 1: Manikin with neck haematoma demonstrated by two layers of dressings sutured together and use of jelly to simulate clotted blood.

- Thyromental Distance > 6cm
- Teeth – no loose teeth/caps/crowns/dentures

Physical Characteristics:

- Height 160cm
- Weight 60kg

Example of Recovery Room Scenario Development

Scenario Start

- Patient dropped to recovery by anaesthetic registrar.
- Handover given by anaesthetic registrar to anaesthetic nurse.
- Patient sitting at 30 degrees with 1 pillow.
- ECG, NIBP and oxygen saturations attached.
- IV access x2.
- IV fluids attached.
- 40% 02 mask attached.

Systems Review on admission to PACU

- Alert and appropriate. Pain score 2/10.
- HR 80 sinus rhythm. BP 120/80.
- 02 Sats 100%. RR 15.
- Steri-strips on surgical incision.

Scenario Progression

- Patient reports difficulty swallowing and feels anxious.

Clinical Assessment

- Patient's voice is hoarse.
- Swelling is noticed around surgical site.

Manikin/Patient behaviour and script for simulated participant

- On arrival in recovery:
- You feel sleepy but comfortable with minimal pain or discomfort.
- Following the first set of observations:
- You start to feel some difficulty swallowing.
- This makes you feel slightly anxious because you feel like you can't swallow your saliva.
- During the application of supplemental oxygen and repositioning:

You then say that you feel like you can't breathe properly and become panicked.

- As the participant is calling for help:

You become increasingly anxious about your breathing and pressure in your neck.

- Once help arrives:

Make stridor sound and keep gesturing towards neck.

- During evacuation of haematoma:
- Complain of some pain during the procedure
- Afterwards you find it easier to breath but still feel anxious

Scenario Development

This scenario is to teach the recognition of the symptoms and signs, and the management of a postoperative neck haematoma. Participants are expected to ask the patients about their symptoms and perform simple measures to begin such as sitting the patient upright and applying some monitors. They are then expected to apply some oxygen and start calling for help. They would be expected to continue requesting help and patient review even in the event of the person contacted saying they are occupied.
The participant who arrives to review the patient is expected to quickly recognise the stridor and the need for urgent action. The participant should identify the necessary equipment required to evacuate the haematoma. The participant may decide to evacuate the haematoma themselves or call for more senior help. It is of vital importance that they contact the relevant personnel: senior surgical assistance; anaesthesia team; theatre. They need to

recognise the urgency required in releasing the haematoma and the need for definitive management in theatre.

Debriefing Points of Importance

Clinical

- Sits patient up to at least 45 degrees.
- Applies supplemental oxygen.
- Calls for appropriate help – senior surgeon and senior anaesthetist.
- Increases frequency of observations.
- Locates neck haematoma evacuation kit.
- Requests difficult airway and arrest trolleys.
- Uses management of suspected neck haematoma following thyroid surgery algorithm.
- Gives dexamethasone or tranexamic acid when indicated.
- Uses SCOOP approach and contents of haematoma evacuation kit to evacuate haematoma.

Communication

- Listens to and addresses patient and colleague's concerns.
- Explains that they will sit the patient up and apply oxygen.
- Explains they have called for help.
- Once help arrives uses ISBAR communication technique to update multi-disciplinary team.

Situation Awareness

- Anticipates equipment and actions required.
- Recognises urgency of situation.
- Recognises need for haematoma evacuation.
- Considers asking for nasendoscope to be brought up for surgeon.
- Considers the next step after evacuation – transport to theatre.