Determining How the Knowledge of Anatomy May Influence Success or Failure in Clinical Practice

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ABSTRACT

Background: Doctors' clinical experience can be an important source of information for content selection in developing clinically oriented anatomy courses. Although expert opinion and personal preference have been the principal source of content for such anatomy courses, studies that actually investigate real-life experiences in clinical practice should contribute more to this enterprise.

Purpose: The purpose of the present study was to investigate how anatomical knowledge influenced success or failure in clinical encounters using a qualitative method.

Method: Doctors working in tertiary, secondary, and primary care settings were invited to complete a critical incident technique questionnaire. Each participant was asked to describe a specific, particularly successful clinical encounter in which they judged that knowledge of anatomy was responsible for the successful outcome and a specific particularly unsuccessful clinical encounter in which they judged lack of knowledge of anatomy was responsible for the failure. Each narrative was analyzed and coded.

Results: The following themes of anatomical knowledge that influenced success or failure in clinical encounters were identified; knowledge that determined ability to: 1) locate anatomical structures topographically; 2) interpret clinical images, 3) assess patients clinically, 4) evaluate congenital anomalies; and 5) interpret laboratory reports. Although additional research is needed, the results can serve as a resource for faculty responsible for developing clinically oriented anatomy teaching curricula. Additionally, the study provides an example of a qualitative research method being used in investigating phenomenon in clinical practice.

Key Words: Anatomy, Teaching, Curricula, Clinical, Qualitative, Success, Failure

INTRODUCTION

In teaching anatomy, many medical schools are increasing the clinical relevance and application to clinical practice.[1,2] The movement to increase clinical relevance and application has been referred to as Clinically Oriented Anatomy Teaching (COAT) by some scholars[3]. One of the fundamental implications of this innovation has been the requirement to develop anatomy curricula that reflect real needs in clinical practice (fit for purpose). The COAT approach attempts to narrow the gap between what is taught in medical school and what is used in clinical settings. This way, educators can concentrate on anatomical knowledge that is important to clinical practice and less on that which is not. While many faculties have defined what they consider 'core' anatomical knowledge for clinical practice, many rely heavily on opinions of experts and individual preferences.[1] However, expert opinion may not match up with what actually happens in clinical practice.

The significance of anatomy to clinical practice is widely conceded, however, there are few studies that have actually investigated how anatomy is used in clinical practice.[1,4,5] Investigating clinical settings present unique methodological challenges and this may be reason for the paucity of research in this area. Some scholars, to address such methodological challenges, have resorted to qualitative methods, such as, the Delphi technique[1,6] and the critical incidence technique.[7,8,9,10,11] The Delphi technique entails building consensus among experts over several iterations of consensus building by ranking items.[6] The critical incident technique, first described by Flanagan,[12] asks of participants to recall a specific incident and to recount the incident focusing on specific aspects. The aspects enquired about include a detailed description of the incident, a description of considerations (knowledge, actions, behaviors) of those involved in the incident, and whether the outcome was successful or a failure. The present study used the critical incident technique.

MATERIALS AND METHODS

Subjects

The study population consisted of 140 doctors and 28 medical students working in both urban and rural hospitals. The doctors were from the five main clinical areas of service, that is, medicine, pediatrics, obstetrics and gynecology, surgery, and general practice. Some authors[10] have asserted that sample size calculations are fruitless for the critical incidence technique because sample size formulas make certain assumptions about the variables that don't hold true for the critical incident technique. Nevertheless, 2000 incidents are considered sufficient for comprehensive job analysis.[10] The principal consideration is that validity is enhanced where fairly large and duly representative incidents and participants reporting them are collected.[8,10] However, for our study, 300 incidents were planned for in view of constraints of time, money, and the numbers of doctors in the study sites,

The Critical Incident Technique Questionnaire

All participants completed a critical incident questionnaire which required them to write a narrative about a clinical situation. The term critical neither refers to a state of emergency nor to the life-threatening nature of a situation but to the pivotal role in the outcome of an activity. For each situation, focused questions guided the participants through a factual description of a clinical situation, the outcome (success or failure), and the anatomical knowledge that was used or was lacking. The questionnaires were developed over several iterations. The initial drafts were piloted with a group of medical student (n = 10), three anatomists, a group of doctors from different departments (n = 12) and volunteers from a Internet listserv for clinical anatomists (n = 10 responses). The final questionnaire was corrected for ambiguity and accuracy. Critical incident questionnaires were distributed to the study sites by an agent a week in advance and collected on designated dates. During distribution all eligible and available personnel in the various categories targeted were recruited on first-to be available basis. Completion of the questionnaires was voluntary and anonymous. The incidents collected in our study were either self-reports or reports of an event that the respondent actually observed.

Data Analysis (Incident Classification)

All narratives were independently read by one researcher without predefined coding criteria. The researcher developed classification of themes by grouping similar statements. Successful, as well as unsuccessful incidents were both used in constructing the themes. In constructing the classification structure, i.e., the themes, no particular attention was paid to frequency of incidents. Each disparate incidence was considered. Statements that were similar or identical were grouped together resulting in distinct classes of statements. Upon developing a final coding frame, all narratives were read and coded. Finally, 6 doctors, three of them also had anatomy qualifications, examined the classes generated by the researcher and indicated agreement; the classes were supported. Data concerning the profile of respondents were examined separately.

RESULTS

One hundred and forty doctors (118 male and 50 female; 24 consultants, 11 senior registrars, 35 registrars, 45 senior house officers, 25 junior house officers) and 28 students returned the critical incident questionnaire. The responding participants represented response rates of 74% for doctors and 93% for students, respectively. The urban to rural ratio was 81% (n=113) to 19% (n=27), however, this difference is not considered to have influenced the results in any considerable manner. The distribution of incidents by specialty is illustrated in table 1.

Theme	Clinical Use	Examples
Locate Topographically	For access during procedures	Venepuncture; lumbar puncture; suprapubic puncture; endotracheal intubation; nasogastric intubation; paracentesis; culdocentensis; pudendal nerve blocks; palpation of the carotid pulses; radial artery arteriopuncture; and thoracentesis.
	To prevent iatrogenic injury	Long thoracic nerve in incisions for chest drains; common peroneal nerve when inserting Steinman pin; ureters at caesarian section; spinal cord in lumbar puncture; vas deferens in herniorrhaphy.

	Situate landmark	Anterior superior iliac spine and pubic tubercles in assessing hernias; deltopectoral triangle in cannulating the subclavian vein; inguinal midpoint in femoral artery location; posterior iliac spines to identify L3, L4 for safe lumbar puncture.
Interpret Clinical Images	Assess normality	Assess size of cerebral ventricles on CT scans; identify and count anterior and posterior ribs on plain chest x-rays; position and size of ureters in urograms.
	Identify defect	Differentiate distended small bowel from normal large bowel; identify a dislocated humerus from its normal position in glenoid fossa; identify distended calyces in urograms; identify space occupying lesions on CT scans.
Assess Clinically	Assess form, size, shape	Size of head for hydrocephalus or microcephaly; integrity of hymen at examination of the female genitalia; recognize deformity in fractures of the long bones, e.g. fracture of the distal radius and ulna (Colles-like fractures).
	Assess function	Assess integrity of named arteries and nerves; localize lesions in CNS cases by assessing different parts of the central nervous system.
Evaluate Congenital Anomalies	Describe & explain anomalies	Conjoined twins, neural tube defects; chromosomal abnormalities, cleft lip.
	Plan intervention (s)	Shunting in hydrocephalus, correction of congenital talipes equinovarus.
Interpret Laboratory Reports	Construe descriptions	Basic tissue types, components of blood.
	Interpret findings	Full blood counts, histopathological reports.

The characteristics of anatomical knowledge that may influence success or failure in clinical practice, identified from the data, are illustrated in table 2.

Clinical Specialty	Type of Incident		Totals
	Successful	Unsuccessful	
Surgery	35	23	58
Medicine	24	16	40
Obstetrics	36	25	61
Paediatrics	27	19	46
General Practice	10	6	16
Totals	132	89	221

These characteristics fell into five groups, that is, anatomical knowledge that determined the ability to, 1) locate anatomical structures topographically; 2) interpret clinical images, 3) assess patients clinically, 4) evaluate congenital anomalies; and 5) interpret laboratory reports. Each characteristic is described in detail below.

Anatomical Knowledge that Determined the Ability to Locate Anatomical Structures Topographically

For access during clinical procedures:

Anatomical knowledge required to locate structures topographically emerged as an important factor for ability to access structures in procedures. For clinical procedures, the clinicians reported requiring knowledge of anatomy to enable them to locate the 'target' structure, e.g., veins for venepuncture, the trachea for endotracheal intubation, the oesophagus for nasogastric intubation, and the pouch of Douglas for culdocentesis. In successful incidents, clinicians reported locating the target structure correctly and timely manner. Specific knowledge of anatomy, for example, the known patterns of the distribution of veins or the surface marking of deep veins, was resorted to when procedures, normally done routinely, required to done 'blindly', e.g., veins not easily visible or palpable.

In many medical emergencies, securing an airway was considered of fundamental importance. Clinicians who were able to correctly identify the trachea, and the surrounding structures, at larnygoscopy, were able to correctly insert the endotracheal tube into the trachea. The importance of this is exemplified by a consultant reporting an incident of how a patient died because a junior doctor had placed the endotracheal tube in the esophagus instead of the trachea. Knowledge of anatomy had implications for procedural skills.

Ability to locate a peripheral nerve in order to inject a local anesthesia was important for nerve block procedures. In one incident, a doctor reported resorting to general anesthesia for a circumcision operation because he was not sure how to apply the local anesthesia to the penis. Many doctors reported incidents of how knowledge of anatomy was used to identify arteries and stop bleeding. Others reported of how lack of anatomical knowledge resulted in the loss of lives because of inability to identify and locate bleeders causing uncontrolled bleeding.

To prevent iatrogenic injury:

Doctors reporting unsuccessful incidents frequently revealed how they accidentally injured nerves because they were not aware about their presence or location in the topographical vicinity of their procedure. In one incident a doctor caused a foot drop because the common peroneal nerve was injured when inserting a Steinmann's pin for patient with a fracture of the femur. Several doctors, working in obstetrics and gynecology, reported incidents of inadvertent injury to the ureters during a hysterectomy operation and in one case during a Caesarian operation. Anatomy is a key element of safe clinical practice.

To situate landmarks:

Effective knowledge about landmarks often helped clinicians to have a mental image of structures lying deep to the skin. Some doctors reported declining to perform the life-saving procedure of pericardiocentesis because they were not sure how to locate and access the pericardial space through the xiphisternum. On one occasion a doctor reported successfully inserting a central venous line in an emergency because he remembered the deltopectoral triangle as a landmark for cannulating the subclavian vein. The doctor reported remembering that the deltopectoral triangle was found two thirds of the distance along the clavicle from the sternoclavicular joint. Another reported how she always insisted that the incision for chest drains should not pass in the mid-axillary because that was where the long thoracic nerve was to be found and injury to the nerve could cause a winged scapula.

Exploratory laparotomies done by general doctors were commonly reported in places where surgeons were not available. Success in exploring the contents of the abdomen depended on knowledge of anatomy. In one incident a doctor successfully located the ligament of Treitz (suspensory duodenal ligament) and it helped him to locate, identify, and inspect the duodenum, jejunum, ileum, and colon, as a result.

Anatomical Knowledge that Determined the Ability to Interpret Clinical Images

To review normal structures:

Clinicians, reporting successful incidents with clinical images, cited ability to recognize how anatomical structures were topographically related (orientation). Failure to correctly recognize what an image represented was common, especially with cross-sectional images. In some cases where clinicians recognized that the image was a cross-sectional representation of the human body they reported inability to work out the level represented.

To identify defects:

A highly valued aspect of interpreting clinical images was the ability to recognize defects. This was reported for fractures, dislocations, differentiating small bowel from large bowel on x-rays taken for intestinal obstruction cases, intravenous urograms, chest x-rays showing infiltrations, hydrocephalus on CT scans, and recognizing foreign bodies on clinical images. Failure to detect or falsely detect defects represented on images resulted in frequent consultations to radiologists for interpretations. In one incident a doctor reported mistaking a metaphyseal cartilage plate, in an x-ray of a limb of a 12-year old boy, for a fracture. This mistake was resolved by consultation with a radiologist.

Anatomical Knowledge that Determined the Ability to Assess Patients Clinically

To assess form, size, shape etc.:

Effective clinical assessment was characterized by the ability to determine what was normal or abnormal with regard, size and shape. Doctors in pediatric settings reported considering the diagnosis of hydrocephalus when they encountered large head circumferences and microcephaly when they encountered abnormally small heads. Some doctors reported inability to assess the fundus of the eye at fundoscopy because the examining doctor could not describe and, as such, recognize the normal form of the fundus.

To assess function:

Knowledge of anatomy was reported as being essential in the assessment of muscle function in cases of nerve injury. Doctors reported incidents of failure to localize the lesion were the central nervous systems was involved. In one example, a doctor could not describe the anatomy of the corticospinal tracts to his colleagues and, as a result, failed to discuss the site of the lesion in the tracts and to explain the complications seen in the patient. Knowledge of anatomy had implications for the correct interpretation of symptoms and signs.

Anatomical Knowledge that Determined the Ability to Evaluate Congenital Anomalies

Describe and explain anomalies:

Neural tube defects (spina bifida, hydrocephalus) and congenital heart defects were the most commonly reported about congenital abnormalities. However, ability to explain the phenomena to fellow health workers required knowledge of correct anatomical nomenclature and ability to diagrammatically represent the structures under discussion. Where such anatomical knowledge was lacking, doctors reported inability to explain the phenomenon to other health workers and parents. The doctors required anatomical knowledge to recognize, describe and explain the nature of congenital abnormalities.

Plan interventions:

It was reported that a crucial aspect of planning the treatment interventions for congenital anomalies was the application of knowledge of anatomy. This was reported to be the case, for example, with hydrocephalus (inserting a shunt in the cerebral ventricles and linking a drain into the peritoneum) and cleft lip/palate (reconstruction of anatomical topography). This meant that doctors had to clearly see the defect and be able to visualize the corrective procedures. Even the doctors that were not necessarily the ones to do the operation required this conceptual understanding in order to comprehend what was planned.

Anatomical Knowledge that Determined the Ability to Interpret Laboratory Reports

Construe descriptions:

Doctors reported receiving laboratory reports that described cellular components of the blood, e.g., lymphocytes, macrophages, neutrophils etc. and tissue types e.g. connective tissue components. They were only able to make sense of such reports because they possessed histological knowledge about the structural and functional nature of these cells and tissues.

Interpret findings:

A doctor reported an incident about a colleague who could not interpret laboratory results, such as, full blood counts and histopathological reports because the reports cited cellular structures of which the colleague lacked knowledge of. This case was cited as defense for learning histology.

DISCUSSION

The present study identified five key themes of knowledge of anatomy that can influence outcomes regarding success or failure in clinical practice. There were no similar studies in the literature with which to compare to. However, there are several points to be borne in mind. Firstly, it is possible that if this study were to be repeated in clinical settings with a significantly different level of care (i.e., whether it was a primary, secondary, or tertiary setting), disease burden, and kind of practitioners, it could yield additional classes of themes. Secondly, participants may have under-reported unsuccessful incidents of themselves. To address this concern in our study participants completed the questionnaires anonymously. It is also recognized that further research, both qualitative and quantitative, is required for greater understanding of anatomical knowledge that influences success or failure in clinical practice.

The present study supports the primacy of anatomy in clinical practice; it found that knowledge of anatomy had implications for procedural skills, safe clinical practice, correct interpretation of symptoms and signs, recognizing and explaining congenital anatomy, to highlight a few.

The present study has practical implications for COAT curricula developers. Many educators traditionally teach regionally and then highlight clinical applications for the region under discussion e.g. the anatomy of the upper limb and then clinical highlights for the upper limb.[1,5] This approach is likely to overshadow the clinical context approach. Using the themes identified in this study, educators can expand on anatomical knowledge that apply to the theme and additionally task students, in student-centred self-directed learning exercises to identify more examples of anatomical knowledge that apply for the theme. This way, the clinical context can be preserved and the relevant anatomy can be learned purposefully. The characteristics of the themes of knowledge of anatomy that can influence success or failure in clinical practice, presented here, may provide insights for instructors who wish to preserve the clinical orientation for their teaching. While not exhaustive, the themes are an example of topics that can be included for COAT in a time-constrained setting.

In conclusion, the study has highlighted two key considerations: firstly, that knowledge of anatomy is important for clinical practice, both for procedural and cognitive skills. In view of the above, anatomy can influence outcomes, i.e., success or failure in clinical practice. Secondly, that qualitative methods, such as the critical incident technique used in the present study, may provide the answer to the methodological challenge of studying how anatomy (and other basic sciences) is used in clinical practice. Data from such studies will broaden the evidence-base from which to select content for clinically oriented anatomy teaching.

REFERENCES

1. Kilroy, D., and Driscoll, P. (2006). Determination of required anatomical knowledge for clinical practice in emergency medicine: national curriculum planning using a modified Delphi technique. *Emergency Medicine Journal,* 23; 693-696.
2. McKeown, P., Heylings, D., Stevenson, M., McKelvey, K., Nixon, J, and McClusky, D. (2003). The impact of curricular change on medical students' knowledge of anatomy. *Medical Education,* 37: 954-961.
3. Tavares, M., and Silva, M. (2002). Evaluation of the Clinical Anatomy Program in the Medical School of Porto by Two Cohorts of Students. *Clinical Anatomy,* 15(1): 56-61.
4. Fasel, J. (1998). Teaching of gross anatomy to medical undergraduates: general practice as a guideline? A synopsis. *Journal of Anatomy,* 192: 305-306.
5. Fasel, J.H., Gailloud, P. and Viet vu, N. (1998). A Core Anatomy Program for the Undergraduate Medical Curriculum. *Academic Medicine,* 73(5): 585-6.
6. Carley, S., Shacklay, J., Driscoll, P., Kilroy, D., and Davis, M. (2006). Exposure or expert? Setting standards for postgraduate education through a Delphi technique. *Emergency Medicine Journal,* 23: 672-674.
7. Victoroff, K. and Hogan, S. (2006). Students' Perceptions of Effective Learning Experiences in Dental School: A Qualitative Study Using a Critical Incident Technique. *Journal of Dental Education,* 70 (2): 124-132.
8. Bryne, M. (2001). Critical incident technique as a qualitative research method. *Association of Operating Room Nurses Journal,* 74(4): 536 – 9.
9. Gilbart, M., Cusimano, M. and Regehr, G. (2001). Evaluating surgical resident selection procedures. *American Journal of Surgery,* 181(3): 221 – 5.
10. Blum, J. and Fitzpatrick, R.(1965). Critical performance requirements for orthopaedic surgery: Part I, Method; Part II, Categories of Performance. Pittsburgh, PA: American Institutes for Research.
11. Hubbard, J.P., Levit, E.J., Schumacher, C.F. and Schnabel, T.G. (1965). An objective evaluation of clinical competence. *The New England Journal of Medicine,* 272(25): 1321 – 1328.
12. Flanagan, John. C. 1954. The Critical Incident Technique. *Psychological Bulletin* 51: 327 - 358.