Patterns of Referral of Trauma Patients for Pan-Scan at Chris Hani Baragwanath Academic Hospital (CHBAH)

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in Diagnostic Radiology

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Declaration

I, Dr Lefu Leshoele , declare that this research report is my own, unaided work. It is being submitted for the degree of MMed (RadD) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

DR LEFU LESHOELE

On this .....th day of .... 2019.

This work is dedicated to my wife and my children - for your sacrifices that made this possible. To my sisters; thanks for all your support! To my friends - I know I have been neglecting you; this too will pass.

Publications and presentations

This work has never been published.

It has never been presented at a congress.

Abstract

AIM:

To analyse referral letters and findings of pan scans performed at Chris Hani Baragwaneth Academic Hospital (CHBAH) in order to distil those that are most useful in predicting injuries.

METHOD:

Request forms and reports of pan-scans performed at CHBAH dated between 16/12/2015 and 16/12/2016 were retrieved. Demographics, indications and findings of the pans-scans were recorded and analysed. Pan-scans indications obtained from referral notes were classified into those relating to the mechanism of injury (MOI), clinical examination parameters and emergency room imaging results.

RESULTS:

A total of 289 patients were enrolled in this study. Most of the patients were male (n=218,75.4%) and young (mean age 33years). Overall, the most common indication for pan-scan was "low GCS" (n=208, 72.0%) and high velocity motor vehicle accidents (MVA) (n=158,54.7%) with most patients having more than one indication (thus indications do not add up to 100%). The most frequent finding was in the chest (n=180, 62.3%) with lung contusions and rib fractures contributing (n=123) 68.5% of this. Head injuries (n=145,50.2%) consisting of surface collections (n=40,28.0%) and brain contusions (n=30,20.8%) followed. There were 39.8%(n=115) incidental findings. There were a few weak but statistically significant correlations between the different indications cited on pan-scan referral with findings by body region. PVA was associated with injuries in more body regions than all the other indications ($p<0.0001$). Abnormalities were detected in 83.4% (n=241) of the scans. 16.6% (n=49) scans were completely normal. 21.8% (n=63) of the scans had abnormality in only one body region, 27.7% in 2 body regions and 24.2% in 3 body regions or more.

CONCLUSIONS:

The results of this study appear to indicate a high yield of pan-scan and thus at face value appropriate use. It must be understood however, that these results do not take into consideration the severity of injuries. But the indications are too widely varied and for the most part non-specific, failing to highlight any specific injury patterns that the radiologist

needs to look out for when dealing with the referrals. Indications for pan-scan need to be more standardised to allow more efficient use of the limited resources.

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To my wife Mamohau Vangile Leshoele, for spending sleepless nights helping me! For dealing with my stress, my disappointments, my tears, my sorrows! For standing by my side through it all!! Thank you for loving me no matter what!! To my children, Busi and Phelo thank you for being patient when I was busy with this work! My love always!!

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List of Abbreviations and Terminology

A:	ABDO	abdomen
	ADI	atlantodental interval
	ANGIO	angiography
	REGION OF INTEREST	ROI
B:	B.O.S	base of skull
	BIRADS	Breast Imaging and Data System
C:	CCJ	cranio-cervical junction
	c-spine	cervical spine
	CDC	centre for disease control
	CHBAH	Chris Hani Baragwaneth Academic Hospital
	CT	computed tomography
D:	DICOM	digital imaging and communications in medicine
	DISLOC	dislocated
E:	EDH	extra-dural haemorrhages
	EFAST	extended focused assessment with sonography for trauma
	ETOH	ET-thyl alc-OH-ol (in this case simply means alcohol)
F:	FAST	focused abdominal sonography for trauma
G:	GCS	Glascow Coma Scale
H:	HB	haemoglobin
I:	IV	intravenous
J:		

K:		
L:	LOC	loss of consciousness
	LODOX	low dose digital x-ray scanner
M:	MVA	Motor Vehicle Accident
	MDCT	multidetector computed tomography
	MOI	mechanism of injury
	MSV	millisieverts
N:		
O:	OECD	Organization of Economic Cooperation Development
P:	PVA	pedestrian vehicle accident
Q:		
R:		
S:	SAS	this is the name of the software used, not an abbreviation
	SAH	sub-arachoidal haemorrhages
	SDH	subdural haemorrhage
T:	TIRADS	Thyroid Imaging Reporting and Data System
U:	UK	United Kingdom
	US	ultrasound
	USA	United States of America
V:	V.BODY	vertebral body
	VR	volume rendering
W:	WBCT	whole body computed tomography

X:

Y:

Z:

1. Introduction

In the year 2000 alone, South Africa suffered an estimated 60 000 trauma related deaths, the leading cause of which was homicide (46%) followed by road traffic accidents and self-inflicted injuries (27%) (1). In South Africa, trauma has been termed "the malignant epidemic"; a term which rings true to this day (2). The leading cause of death in the United States amongst those aged 46 and younger, is trauma (3, 4). The US Department of Health and Human Services Centres For Disease Control and Prevention (CDC) reported that road accident related injuries accounted for 16.7% of all injury related deaths (poisoning with 29.7% incidence is also included under injuries) in 2016 (5), while homicides and suicides contributed 28.7% and 38.5% of all deaths in people aged between 10 and 44 years in the same year respectively (6). According to Jiang *et al* approximately 5.1 million people died from injuries in 2010, making trauma the leading cause of death for people between 1 and 45 years of age (7). Major trauma is amongst the top ten causes of disease burden in North America and Europe (8).

Computed Tomography (CT) is defined as a medical imaging modality in which several sequential X-ray images of a body part(s) are taken and reconstructed by computer, to form images by which screening and diagnosis of disease can be achieved (9). CT was found to have a specificity of 90%, sensitivity of 80% and accuracy of 90% in a recent study on blunt abdominal trauma, cementing it's indispensible role in trauma management(10); especially in academic institutions where after-hour supervision of radiology trainees by qualified radiologists tends to be unavailable (11). It has, during the last 20 years, proved itself as an excellent tool for the diagnosis and management of blunt trauma patients who are haemodynamically stable (11). With its non-contrasted / contrasted multi-detector, multi-planar features, the ability of CT in demonstrating head, vascular, hollow and solid organ injury is second to none (12).

When CT is used to perform a scan of the brain, neck, chest, abdomen and pelvis especially in the trauma setting; this can be referred to as Whole Body Computed

Tomography Scan (WBCT), pan-scan or pan-CT (13). As Harvey first described it in Germany in 1997; the scan is done continuously in one pass, covering all the body regions from the head to the proximal femora or if indicated down to the toes (14).

Pan-scan has increasingly become an integral part of the early management of trauma patients which has, with much controversy, been demonstrated to correlate positively with reduced mortality (15). Thus the number of CT requests, especially pan-scans, is progressively increasing, and with it the radiation exposure to the patient and the cost of health care (16).

This study aimed to perform an audit of the referral patterns and yield of pan-scans performed at Chris Hani Baragwaneth Academic Hospital (CHBAH); the largest hospital in South Africa (17). CHBAH, located in Soweto, Johannesburg, South Africa, is one of the four Level 1 teaching hospitals linked with The University of The Witwatersrand, with a capacity according to hospital management, of 2 888 beds; 2 639 of which are operational as of September 2015 making it the biggest in the country.

1.1. Literature review

1.1.1. International trends of whole body computed tomography

For many years the benchmark standard of care in many trauma centres internationally has consisted of a staggered diagnostic approach starting from clinical examination, followed by Focused Abdominal Sonography for Trauma (FAST), in conjunction with plain radiography of the affected body regions and if indicated additional focused computed tomography (CT) of relevant body areas (7, 18). Management of trauma patients has since changed and become positively impacted by the advent of CT use in trauma (12). The utilisation of WBCT scan in the decisive trauma assessment is on an upward trend (19), having increased from 5% in 2002 to 46% in 2010 (7). It has found wide acceptance as a definitive diagnostic modality in major trauma management (20).

Increasing use of CT in Canada and Germany is associated with decreasing mortality in trauma patients(9) (13). With 97.3 CT scanners per million people, Japan is amongst the countries with the highest number of CT scanners; definitely boasting the highest ratio amongst the 38 countries of the Organization of Economic Cooperation Development (OECD) (21). Most tertiary trauma and emergency centres in Japan have easy access to at least a 16 to 64 slice scanner and the problem of time and transportation is obviated (21).

1.1.2. Africa, especially South Africa

In most developing countries the main hospitals utilise 16 to 64 multi-detector row CT scanners (2). Unfortunately most African health facilities are under-resourced, and in places like East Africa expensive medical tools such as CT are rare (11).

In South Africa, a practice of routine CT scan for gunshot abdomen in patients with no tangible indication for surgery, has been advocated and has also evolved without any real evidence demonstrating the exact benefit of CT over serial clinical examination; whereupon a Cape Town study challenged this practice, eventually concluding that selective use of CT is safe and effective (12).

Trends in the use of WBCT for trauma in developing countries in Africa, with South Africa in particular, have not been adequately researched. A paediatric study in Stellenbosch found that easier access to a CT scanner may result in an increase in the number of negative pan-scans, and that guidelines need to be developed to direct CT scanning in cases where there is strong clinical suspicion or other investigations are suggestive of blunt injury (22). In Pietermaritzburg, Oosthuizen expressed concern over the wide use of pan-scan in blunt polytrauma due to associated radiation risks, but concluded that it is useful and influences management even when it yields negative findings (23).

In the South Africa setting, a common mechanism of injury known as ''Mob justice" needs to be briefly discussed. Mob justice is when a large crowd of people – often community members - become violent, taking the law into their own hands against a perceived offender; making an accusation, judgement and delivery of punishment in the same incidence (24). Mob justice can be likened to vigilantism and is thought to be related not only the frustration with crime in South Africa but also to the violent history of strife under apartheid (25). Even today violence in South Africa is still a major reason for trauma related hospital visits. In a recent study Steyn *et al* found that 50.64% of all hospital visits were violence related at Pelonomi Hospital in Bloemfontein South Africa, costing the state in excess of R35 million during the last 6 months of 2017 (26).

1.1.3. Pan-scan and the elderly

Special mention of the elderly is warranted as it has been demonstrated that patients over 65 years of age suffer a 10 times higher mortality rate from overly more grievous injuries than their younger counterparts for the same mechanism of injury (27). A high index of suspicion, with a low threshold for WBCT in this group of patients should be maintained because of their co-morbid conditions (e.g. osteoporosis) and low physiological reserve (14, 28, 29).

1.1.4. Indications for pan-scan

A medical indication is a logical basis upon which medical diagnostic and therapeutic processes can be pursued; that is derived from facts and clinical judgement about the physical and/or psychological status of a patient (30). A medical indication can be reasonably expected to have a basis on medical evidence (31). Controversy surrounds the indications, as well as, mortality benefits of routine use of WBCT scanning in trauma (21). The clinician must use their discretion in each individual blunt trauma case, because applying a blanket criteria for WBCT scanning in trauma patients would result in increased WBCT scans performed without an increase in overall accuracy (32). Mechanism of injury alone is not sufficient as a criteria for performing pan-scan, but it needs to be used in conjunction with a thorough clinical assessment by the trauma team (33).

Indications for pans-scan in one German (34) study were classified into 3 broad categories; namely mechanism of injury in the first category, clinically apparent injuries in category 2 and in the third category, vital signs. A pan-scan was indicated if a patient satisfied any one criteria (34). Although there are slight differences in the details of the criteria, the general principles are similar to those suggested by a review article from the United Kingdom (UK) whereby a patient needed to satisfy one or more criteria from 2 different categories (14). A well-established pre-admission clinical evaluation criteria for defining severe trauma (known as the Vittel criteria) has also been used to select patients for whom WBCT was to be performed if they satisfied at least one of the criteria (35). These indications have been compiled into a comparative table; Table 1.1. Note the similarities of these international indications that have been used to select patients for WBCT scanning.

Table 1.1. Comparative indications for the performance of WBCT for trauma patients internationally

Category A			
Indication	***German study (34): Mechanism of trauma***	***UK review article (14): High risk mechanism of trauma***	***Vittel Criteria (35): Kinetic elements***
Fall	> 5m	>2m	>6m
Incarceration in vehicle	Patient trapped in a car	Prolonged extrication > 15min	Vehicle deformation
Collision type	Roll-over, head-on	Pedestrian/bicycle/motorbike vs vehicle	Victim thrown or run-over
Ejection	Ejection from car	Ejection of casualty from vehicle	Ejection from vehicle
Death of companion	In same passenger compartment	Another passenger in same vehicle	Other passenger died same accident
Speed	High speed crash		Global assessment: Estimated Speed/helmet/seatbelt
Type of other vehicle	Crash against a truck		
Pedestrian	Pedestrian run over	Pedestrian vs vehicle	
Explosion	With buried other person		Blast

Category B			
Indication	***German study (34): Clinical apparent injuries***	***UK Review article (14): Anatomical***	***Vittel criteria (35): Anatomical injuries***
Injury type	Open Chest	Visible injury to >2 body regions (head, abdomen, chest, pelvis, long bones)	Penetrating trauma: head, neck, chest, abdomen, pelvis, arm, thigh
	Open abdominal wound		
	Flail chest		Flail chest
	Major pelvic injury		Smashed pelvis
	Two or more proximal long bone #s		
	Amputation proximal to wrist or ankle		Amputation at the wrist, waste or above
		Hard signs of vascular injury (expanding haematoma, deep laceration over arterial course)	Acute ischaemia of a limb
		Hard sings of spinal cord injury	Suspected spinal cord injury
			Severe burn, smoke inhalation

Category C			
Indication	***German study (34): Vital signs***	***UK Review article (14): Physiological***	***Vittel criteria (35): Resuscitation prior to admission***
	Intubated, GCS<9 on scene	Intubated/surgical airway with GCS<12	Assisted ventilation
	Systolic BP<80mmHg	Systolic BP<90mmHg in ED	Colloid fluid >1000ml, catecholamines
	Respiration<10 or >29	Respiration<10 or >30	Respiratory Failure
	Saturation<90%	Pulse > 120 in ED	Inflated anti-shock trousers
		Age >65	Age >65 years
		Warfarinised patient	Dyscrasia
			Heart or coronary failure
			Pregnancy (2nd or 3rd trimester)

1.1.5. Radiation dosing in pan-scan

Radiation exposure is measured in millisieverts (mSv). In order to start discussing radiation dose, one needs to understand Effective Dose (ED), which is used to convert localized radiation dose to an equivalent dose in a reference patient, assuming whole body radiation exposure (9).

CT is the biggest contributor to imaging related radiation, with an overall effective dose of 4 million person-Sv/year (36). The effective dose of pan-scan (29.5mSv) is almost double that of non-pan-scan trauma imaging work-up (15.9mSv, *P*<.001), but the time to complete imaging work-up is reduced more than five-fold (12min versus 72min, P<.001)

(37). This additional 15mSv resulting from pan-scan translates into 1 in 1 250 cancer mortality – not counting the incidences of non-fatal cancer (38).

It is generally believed that radiation exposure from CT scanning increases cancer life time risk; and in patients younger than 45 years of age, the additional cancer mortality risk due to pan-scan is thought to be greater than 0.08% (4). Small but measurable; many studies have demonstrated that trauma patients get significant radiation exposure with an increased cancer related mortality risk, therefore the need for appropriate patient selection to ensure that only the most appropriate patients are scanned is also as well established (39).

Roughly 190 additional cancer deaths per 100 000 population are attributable to pan-scan according to one Canadian study (14). Data is emerging suggesting that although the CT related radiation has increased since the introduction of a dedicated WBCT protocol, total effective dose throughout hospital admission comparing those who get WBCT and those who do not, is comparable (20 vs 24mSv) (40).

1.1.6. This project in context: The Controversy

The management of high velocity blunt trauma employs pan-scan with increasing frequency in developed nations such in Europe, United States of America (USA), as well as, Japan (9). This has however, sparked controversy and much debate, with some advocating for the routine use of pan-scan to detect injuries not obvious on clinical examination as part of organised trauma systems, while others opt for a more conservative approach of using CT selectively as guided by clinical judgement (4).

The proponents of pan-scan argue that clinical history is often not available, and in the few cases that it is, it is misleading or inadequate, with physical examination reliability declining to 16% for eliciting intra-abdominal injuries in cases where there is suspicion of head injury or there is decreased level of consciousness (13). That said, it is interesting to note that evidence is established demonstrating that using a standard set of clinical criteria; a doctor will only miss a single cervical spinal injury once every 125 years of practice, and in such cases this miss will most likely be of little clinical significance, if at all (41). But pan-scan proponents further argue that in younger patients with adequate cardiovascular compensatory mechanisms, occult haemorrhage can mislead the clinician into missing serious injury (4).

On the other hand, opponents to routine use of pan-CT in major trauma assert that there is no evidence that pan-scan even reduces the risk of litigation in trauma practice (41). Quite to the contrary; there is a suggestion that with less interaction with their patients that results from CT screening, litigation may actually go up from the current 1 in 25 000 risk in Texas (42). They further argue that a routine pan-CT strategy is not without drawbacks such as increasing radiation exposure and increasing cost (39). Interestingly, Lee *et al* conducted a study in California which suggested that a routine pan-scan strategy has cost benefits over a selective scanning model in patients who have no obvious external injuries and a moderate mechanism of injury (43). Other concerns include evidence according to some studies that pan-CT has a high rate of false-negative findings; while even others argue that missed clinical injuries in selective CT use are not necessarily clinically significant (4). The process of transporting and positioning major trauma patients for CT scanning has also been cited as a risk for patient hemodynamic deterioration (18).

1.2. Study objectives

This study aims to:

Categorise trauma WBCT requests at CHBAH according to indication.

Determine the rate of positive findings yielded from such referrals.

Distil the main indications for which trauma patients are referred for pan-scan at CHBAH.

Discern if there is any association between specific indications and specific findings that can help predict likely injury types based on the referral letter.

2. Materials and methods

The principal investigator conducted a pilot sample of 20 pan-scan reports with the associated referral letters (request forms). Each referral letter was reviewed with the aim of finding what the indications were, that the referring clinician mentions for the pan-scan.

The indications mentioned with high frequency were made into subheadings under the major headings of: mechanism of injury (MOI), emergency room findings (including vital signs where available) and emergency room imaging (extended focused assessment with sonography for trauma (EFAST) and LODOX. Under mechanism of injury, the following sub-indications were developed: high velocity motor vehicle accident (MVA), death of another in same vehicle/same accident scene, trapped in vehicle, vehicle rolled/head on collision, ejected from vehicle/fall from back of open vehicle (bakkie)/motor bike accident (MBA), pedestrian vehicle collision or accident (PVA), fall from height, mob justice or mob assault and in some cases no mechanism of injury was specified (not specified).

Under the heading of emergency room findings (also referred to as clinical parameters) the following sub-headings were developed: head injury clinically, post-laparotomy, tender abdomen (abdo), spine tenderness/deformity, low Glascow Coma Scale (GCS)/loss of consciousness (LOC), obvious fractures (in long bones not specifying if proximal or distal part of the limb), haematuria (not specifying if microscopic or macroscopic), dropping haemoglobin level (dropping HB), being drunk in the opinion of the referring clinician (ETOH).

In the case that the indication was mentioned, other than those already tabulated, the findings, were recorded under the sub-heading of "other". Under emergency room imaging there were only 2 sub-headings, namely x-ray findings/LODOX findings and EFAST. If any finding from x-ray was mentioned it was recorded as a positive under x-ray, but for EFAST a note was made as to whether or not it was done, and if done whether or not it was positive.

The pan-scan findings were recorded under the headings of head (including face), c-spine, chest, abdomen, pelvis and long bone fractures. If angiograms were also requested in certain regions, they were also listed under that body region to show whether it was done or not, and whether it was positive or not.

Under head the following sub-findings were recorded: surface collections (included extra-dural (EDH), sub-dural (SDH) or sub-arachnoid (SAH) haemorrhages), midline shift (size not specified), attenuation of the basal cisterns, tonsillar herniation, diffuse axonal injury, brain contusion, base of skull fracture (BOS), calvarial fracture and facial bone fracture.

Under c-spine the following sub-findings were developed referring to fractures, dislocations or subluxations of bony structures/joints in this body region: atlantodental interval (ADI), cranio-cervical junction (CCJ), listhesis (loss of alignment not specifying whether anterolisthesis or retrolisthesis), vertebral body (v. body), posterior elements, facet joint, transverse process, spinal stenosis, angiography (angio) done, angio positive (or not).

Under chest the following sub-findings were developed: haemothorax, pneumothorax, surgical emphysema, pneumomediastinum, great vessels, lung contusion/cysts, fractures of the vertebral body (v. body), fracture of the posterior elements, fracture of the transverse process, spinal stenosis, fracture of the scapula/sternum/clavicle, rib fracture, dislocation of facet joints, vertebral body mal-alignment (listhesis), angio done, angio positive.

A mention must be made that conventionally the word posterior elements include the pedicles, laminae, transverse processes, articular processes and spinous processes (44). For the purpose of this study however, transverse and articular processes were considered separately.

Under abdomen the following sub-findings were developed for injuries to different organs: liver, spleen, kidneys, free air, aorta, fractures to vertebral body, transverse process, posterior elements, spinal stenosis, dislocation of facet joints, vertebral body dislocation (listhesis), spinal stenosis, angio done, angio positive.

Under pelvis the following sub-findings were developed: bladder rupture intraperitoneal, bladder rupture extra-peritoneal, angio done, angio positive, fractures to acetabulum, sacrum, ischium, pubis, coccyx and joint dissociation/dislocation.

Under limbs: fracture to lower limb, fracture to upper limb, angio done, angio positive. Finally incidental findings were listed under just one heading.

Having developed the data collection sheet as above, ethics approval was applied for and approved and the sheet was subsequently used for the study.

The scans have been performed on the Toshiba Acquillon 64 (64 slice) and the Toshiba Acquillon CX (128 slice). Most of the scans were reported by the registrar on call in cases where the patients were scanned after working hours. The reports were subsequently reviewed by a consultant radiologist at the first available opportunity on the next working day. Corrections were recorded and communicated to the referring clinician. For those patients who got scanned within working hours, the reports were written by the registrar under direct supervision by the consultant radiologist on the floor at that moment and finalised. The results recorded were from the final report with consultant corrections or input.

The protocol for WBCT at CHBAH included a non-contrast scan of the brain and C-spine with bony reconstructions, followed by a contrasted (100ml of Omnipaque or Jopamiron injected at 3ml per second) CT body with a 40 second delay for chest and 60 seconds delay for abdomen and pelvis. The chest was routinely scanned in arterial phase and the the abdomen in both the arterial and porto-venous phases. For angiograms contrast was injected at a rate of 5ml per second when indicated before CT body using automatic scan activation when Hounsfield Units on a specific area of interest (ROI) had increased to a pre-determined level because of the presence of contrast. Angiography was done only when specifically requested or indicated in the specific affected region as per discussion with the referring clinician. Post contrast scanning of the body would then follow. Cystograms were only done if the radiologist deemed in necessary after a preliminary vies of the scan and/or if specifically requested by the referrer. The CT brain and c-spine were routinely done prior to any use of intravenous contrast.

2.1. Inclusion and exclusion criteria

This is a retrospective cross-secrional study of the patients who underwent a trauma related pan-scan at CHBAH within the one year period from the 16th December 2015 to the 16th December 2016 was included. Patients below the age of 18 were excluded, as well as, patients whose data was incomplete, illegible or missing.

2.2. Data collection

Hard copy files stored by the radiology department were accessed. This study was focused in a time period in which PACS had just been introduced and was often offline and unreliable. The principal investigator paged through thousands of referral forms to identify those that were for trauma related pan-scan and the attached reports.

All request forms and reports of pan-scans performed at CHBAH dated between 16/12/2015 and 16/12/2016 were selected and information from them entered into the pre-determined tables. Demographics, as well as, any information that the referring clinician had written on the form motivating for the pan-scan was recorded. Any clinical information written on the request form was counted as an indication for the scan and the data entered into an excel spread-sheet. If a particular indication was rarely used it was listed under ''other''. Any finding reported by the radiologist was recorded under anatomical categories starting: head, neck, chest, abdomen, pelvis, upper limb, lower limb and in each category angiography findings were also captured. The tables had to be re-adjusted a few times to accommodate a few new variables that appeared frequently. Some of the rarer variables were recorded on a separate spread-sheet and for this study left out.

Under each data collection heading the digit ''0'' represented a negative finding and the digit ''1'' a positive finding. Severity of injury was not be graded, rather the presence or absence of injury of a specific kind such as subdural haemorrhage (SDH), base of skull (B.O.S.) fracture, long bone fracture and others as discovered from the radiological reports.

2.5. Statistical analysis

2.5.1. Data preparation / cleaning

The principal investigator cleaned the data in consultation with the statistician and the supervisor. This process resulted in the reduction of the sample size.

2.5.2. Sample size

Sample size requirements are based on the key research question, in this case the estimation of proportions (e.g. the proportion of a particular CT finding). Based on worst-case (for sample size) estimates of 50%, 5% precision and the 95% confidence level, a sample size of 385 would be required. The actual sample size of 289 used in this study corresponds to a precision of 5.8% (rather than 5.0%), which is adequate for a study of this nature. The sample size is also adequate for the testing of associations between indications for pan-scan and findings.

Sample size for proportions was determined using the formula(45):

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where n = sample size,

Z = Z-statistic for the chosen level of confidence,

P = expected prevalence or proportion

d = precision

2.5.3. Analysis: general

Descriptive analysis of the data was carried out as follows: categorical variables were summarised by frequency and percentage tabulation, and illustrated by means of bar charts. Continuous variables were summarised by the mean, standard deviation, median and inter-quartile range, and their distribution illustrated by means of histograms.

Fisher's exact test was used to test the association between selected indicators and findings. The strength of the associations was measured by the phi coefficient. The following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

Data analysis was carried out using SAS. The 5% significance level was used throughout. In other words, p-values <0.05 indicate significant results.

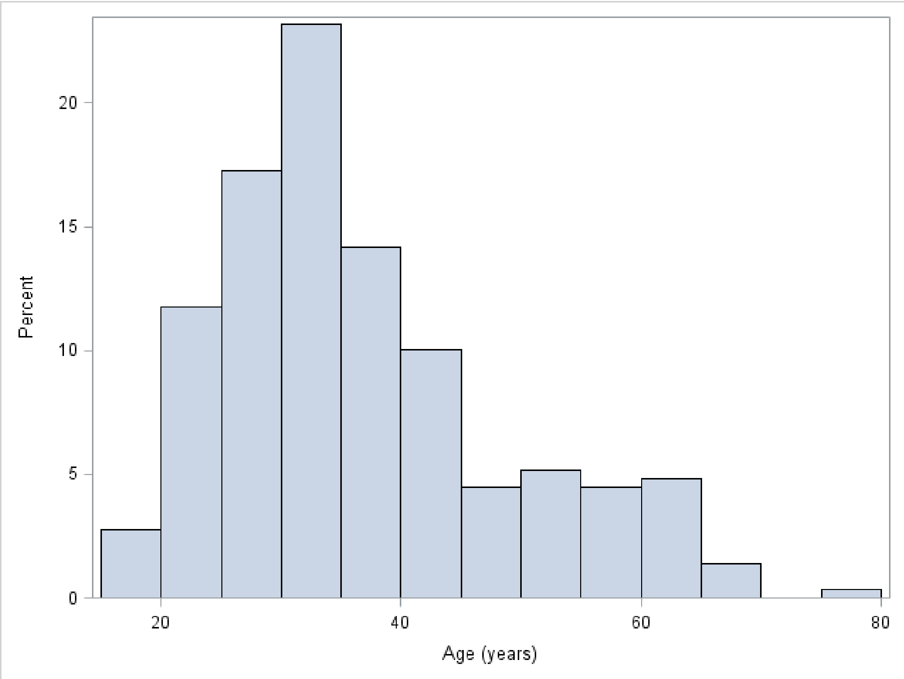
3. Results

3.1. Descriptive analysis of the study group.

3.1.2. Demographics.

Age: The study population had a median age of 33 years (inter-quartile range 28-42y; range 18-77y). See Figure 1 below.

Figure 1. Age Distribution of the study group



Gender:

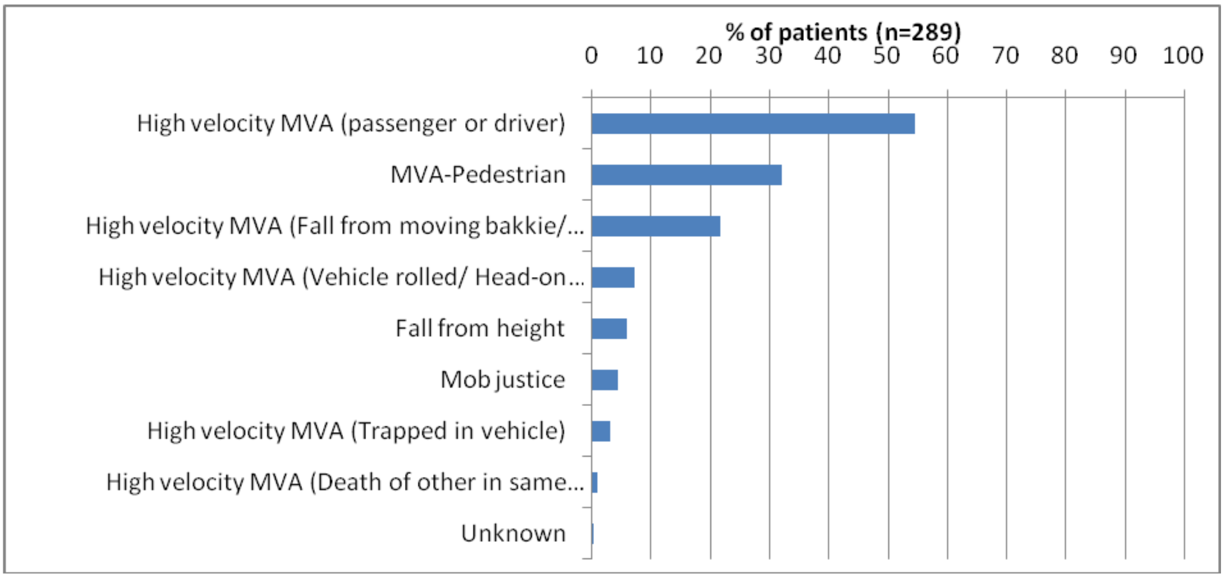
Males comprised 75.4% of the study population.

3.2. Indications given for the pan-scan request

3.2.1. Indications by mechanism of injury (MOI)

The different MOI's had different rates of occurrence as shown below (Figure 2.) Due to the fact that some of the patients had more than one MOI, the percentages do not sum up to 100%. High-velocity Motor Vehicle Accident (MVA) passenger/driver was the most frequent MOI (54.7%) and followed by MVA-pedestrian (32.2%). High-velocity MVA (passenger/driver) means the MOI involved was MVA and further descriptors of the accident (e.g. high-velocity MVA (trapped in vehicle) are in some cases provided while in others they are not.

Figure 2: Indications by MOI

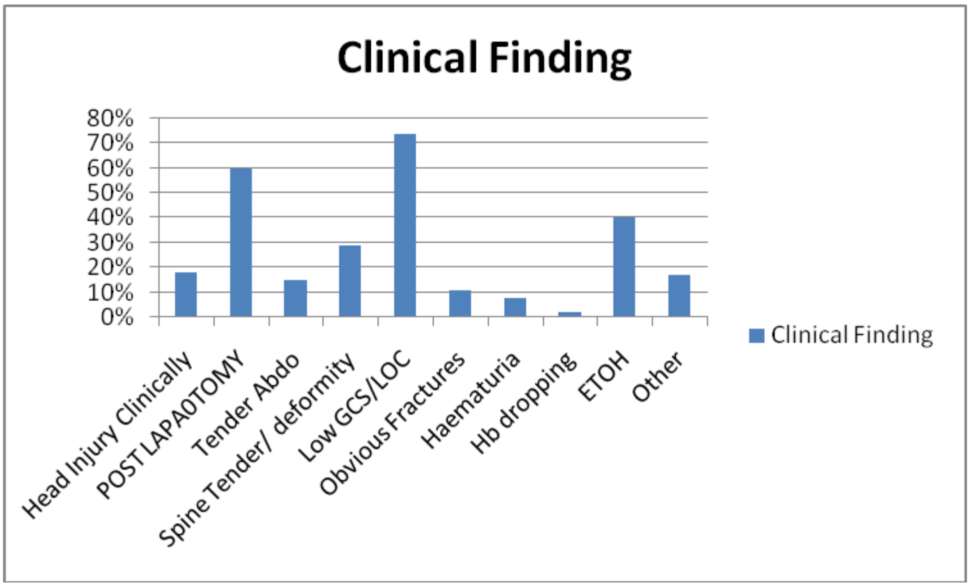


3.2.2. Indication by clinical parameters/emergency room findings

These are the reasons that clinicians after examination of the patient, have mentioned in motivating for the performance of a pan-scan. Figure 3 below shows how often each of the different findings on clinical examination in the emergency room were mentioned in the referral letter as indications for pan-scan. It must be noted that the percentages will not sum up to 100% owing to the fact that some of the patients had more than one indication under this heading.

Low Glasgow Coma Scale/Loss of Consciousness (GCS/LOC) (72.0%) was by far the most common finding on clinical examination in the emergency room, with tender spine and/deformity (31.1%) making a distant second. A dropping haemoglobin (Hb) level implies that the patient has an internal site of bleeding (in cases of blunt trauma with no visible external injuries) and this was one of the most rarely cited reasons for pan-scan requests at 2.1%.

Figure 3. Indications by clinical examination findings in the emergency room



3.2.3. Indication by emergency room imaging

The emergency room at CHBAH has ready access x-ray facilities including LODOX, as well as an ultrasound machine for the trauma doctor to perform Extended Focused Assessment with Sonography (EFAST). Often the request for CT scan is preceded by x-ray, LODOX and/or EFAST examination.

41.5% of the patients (n=120/289) had EFAST mentioned as one of the reasons for the pan-scan request. It was positive in 26.3% (n=76/289) of these. 41.2% of all the patients in the study group had positive X-ray/LODOX findings (see table 3.4. below). It is unclear how many patients had had imaging in the emergency room prior to referral for pan-scan as this was only mentioned when there was a positive finding used as an indicator.

Table 3.4. Indication by emergency room imaging

ER imaging	EFAST done	120	41.5
	Positive EFAST	76	26.3
	X-ray / LODOX findings	119	41.2

3.2.4. Other indications

These were widely varied and not frequent enough to form their own column under indications. Examples under this would include things like: requested by Prof, wall fell on him, P4 on scene, was working under car and it fell on him, distracting injury, electrocution, expanding haematoma, priapism and urinary incontinence on scene, blood on PR, worsening saturations.

3.3. Findings of the pan-scans

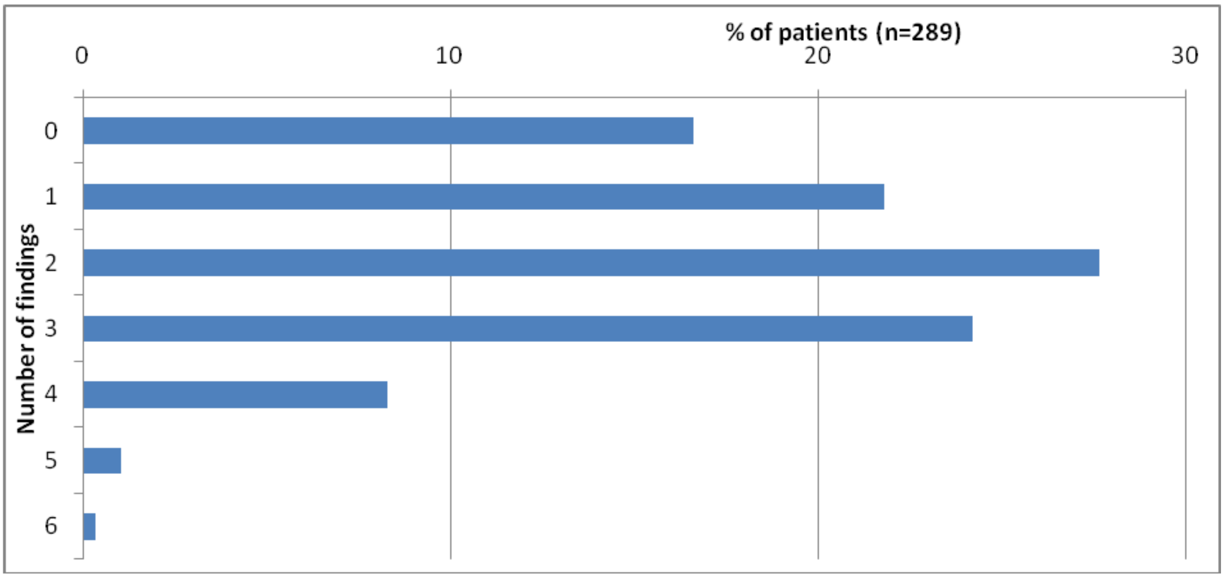
3.3.1. Findings overall

A total of 289 scans were analysed. Overall, at least one or more injury was recorded in 83.4% of the patients undergoing pan-scan in this study. There was absolutely no positive findings in 16.6% of the patients (see table 3.5 below). 73.7% of the patients were found to have between 1 and 3 injuries/positive findings at the same time as shown in figure 4 below. Note that incidental findings did not contribute to the overall positive findings and were treated separately.

Table 3.5. Findings overall

Findings: Overall	None	48	16.6
	One or more	241	83.4

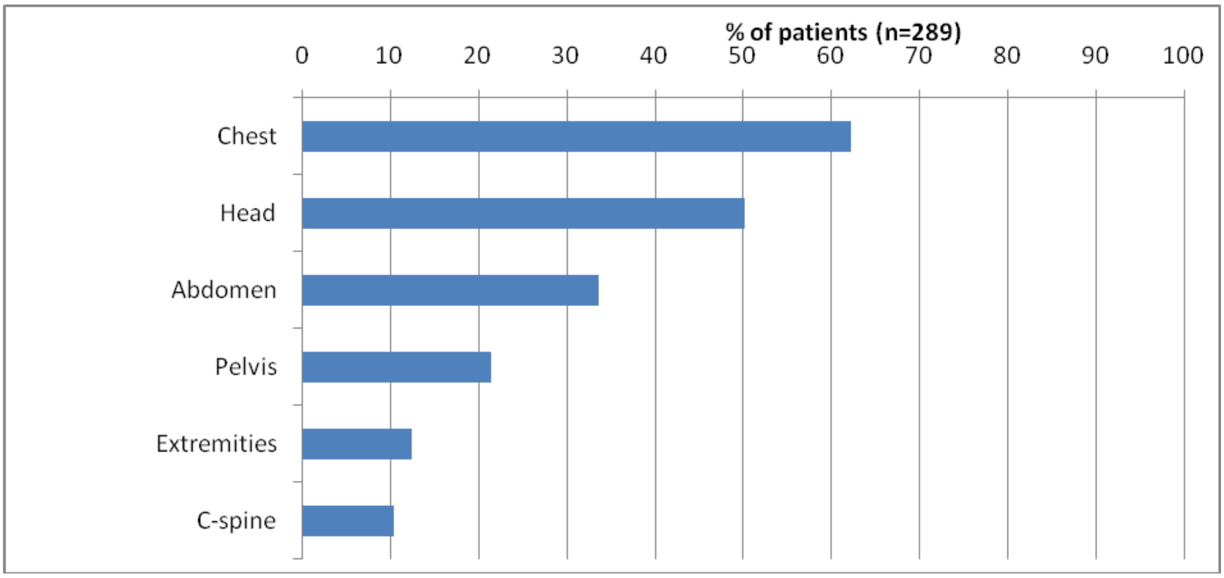
Figure 4: Patients who sustained multiple injuries



3.3.2. Findings by anatomical region

Positive findings were recorded in the different anatomical regions as shown in figure 5 below. Note that the percentages do not sum to 100% since some patients had findings in more than one anatomical region. The most common injuries on pan-scan were in the chest (62.3%), and head (50.2%).

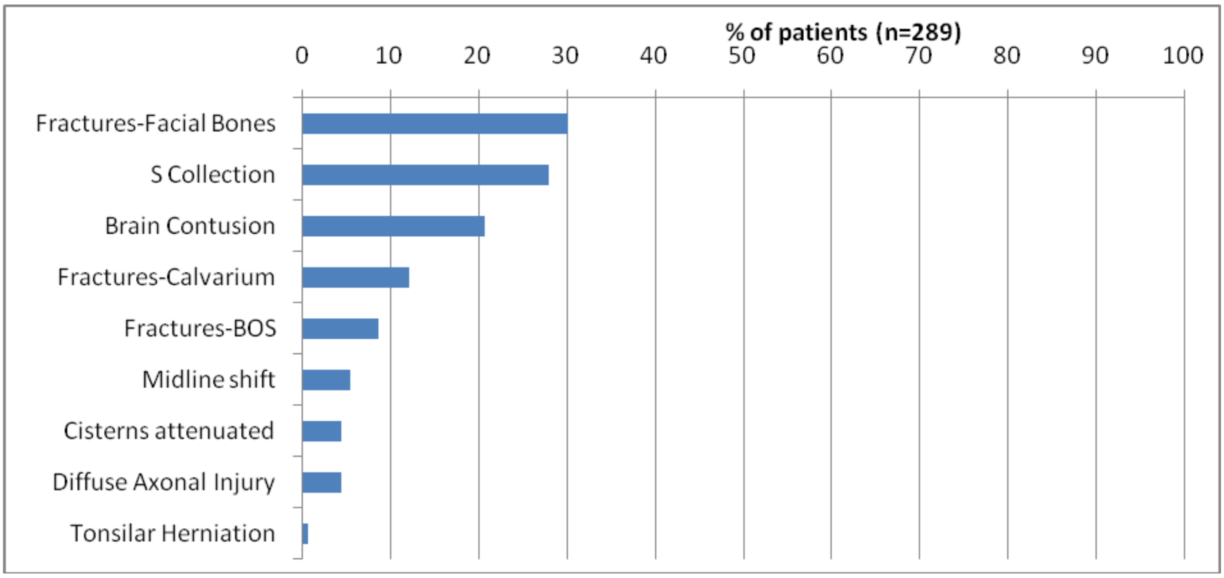
Figure 5. Findings by region



3.3.3. Findings in the head

50.2% of the patients were found to have sustained one or more injuries in the head region. Facial regions were included in this number. The different types of head region injuries are demonstrated in figure 6 below. Facial bone fractures were the most common injuries (30.1%) in the head region followed by surface collections (S Collection) (28.0%), and brain contusions (haemorrhagic and non-haemorrhagic) (20.8%).

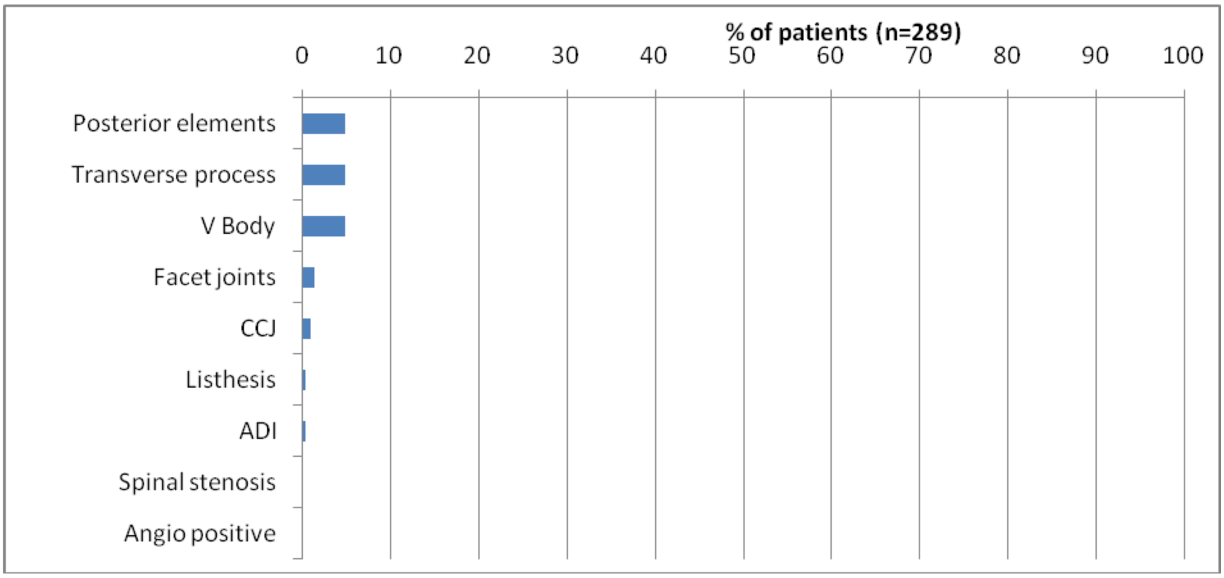
Figure 6 .Findings in the head



3.3.4. Cervical spine findings

The findings here are primarily fractures and they are divided according to the part of the vertebral column involved. Stability or degree of cervical spine injuries was not qualified. The prevalence of the different fracture types recorded is demonstrated in Figure 7 below. Overall, one or more C-spine fractures was present in 10.4% of the patients. Fractures were equally prevalent in the posterior elements/column, transverse processes and vertebral bodies (V Body fracture) at 4.8% each. Only in 0.3% (n=1) of the cases was an angiogram done; which turned out to be negative.

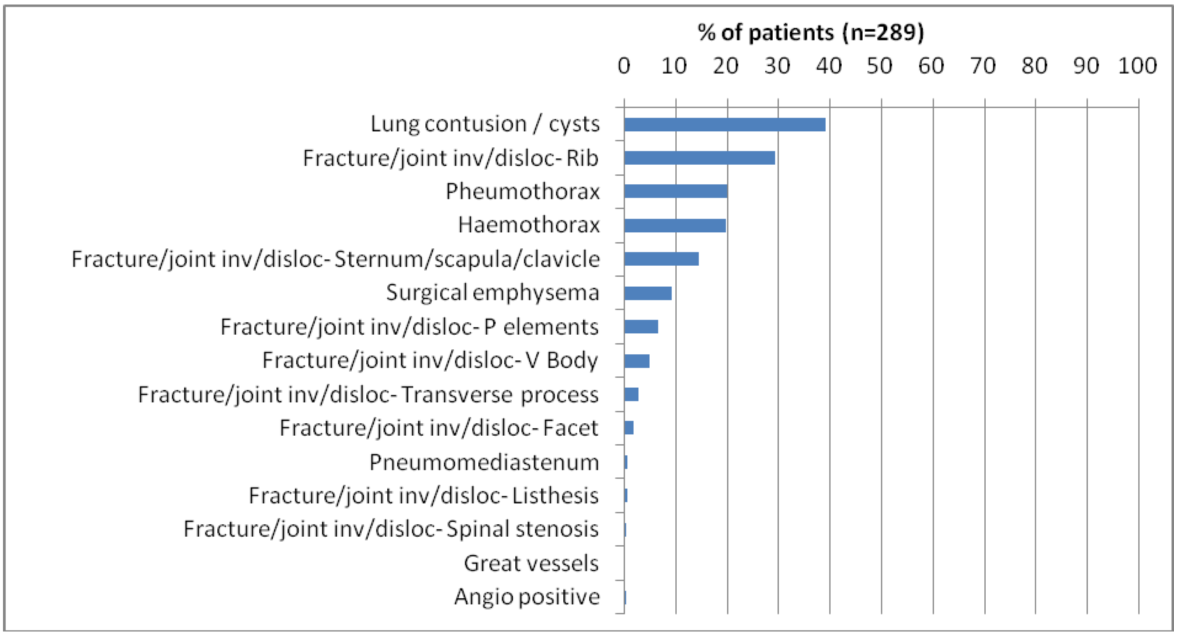
Figure 7. Cervical spine findings



3.3.5. Findings in the chest

Overall, one or more chest injury was recorded in 62.3% of the study population. The prevalence of the different chest findings is shown below. Traumatic lung contusion/cysts were the most common in this body region (39.1%) followed by rib fracture/dislocation (29.4%). A CT angiogram was done in 0.7% (n=2) of cases, with one (0.3%) vascular injury being detected. The prevalence of the different chest injuries found on pan-scan is graphically represented with Figure 8 below. Some of the fracture lines extended to the joint space (joint inv) or the associated joint was dislocated (disloc). Some fractures involved the vertebral body (V body).

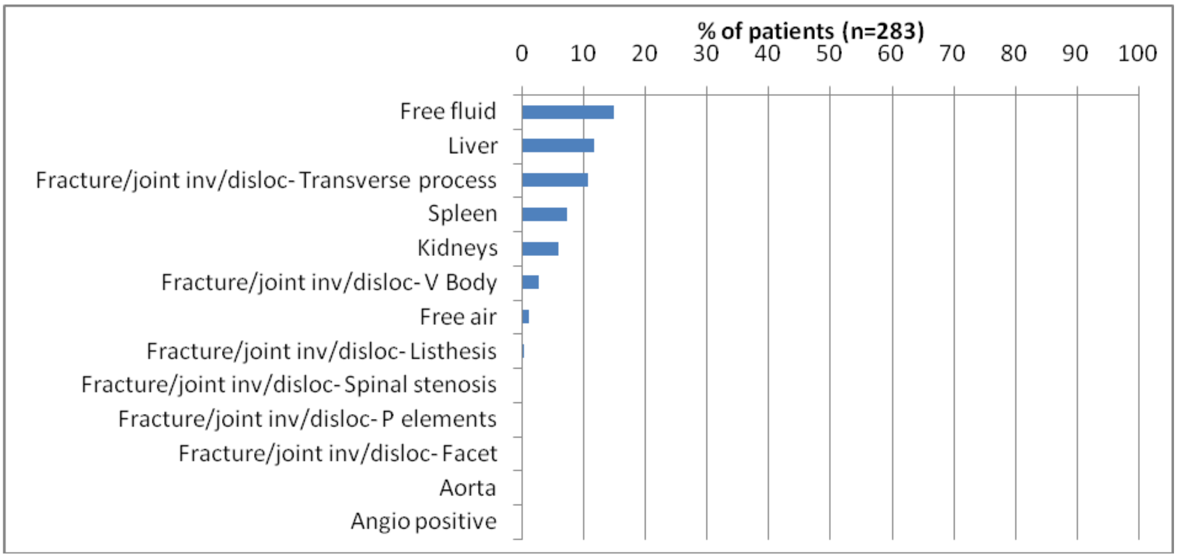
Figure 8. Chest findings



3.3.6. Abdomen findings

Overall, 33.6% of the patients had at least one or more injuries in the abdomen, as detected on pan-scan. Intra-abdominal free fluid (14.9%) was the most prevalent finding. Liver laceration/injury/contusion (11.8%) was the next most common finding in this body region. Transverse process fractures ranked (10.7%) as the 3rd most common injury in the abdomen region. No angiograms were done. Figure 9 below demonstrates the rates of the different abdominal injuries.

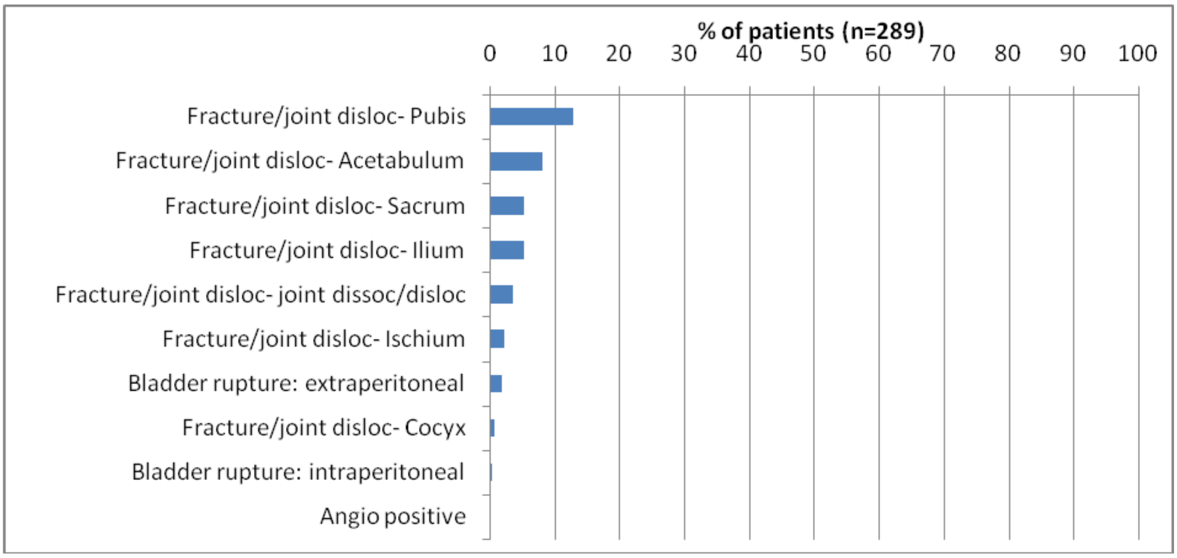
Figure 9. Abdominal findings



3.3.7. Findings in the pelvis

Overall, at least one or more injuries were found in the pelvic region in 21.5% of the patients. Pubic bone (12.8%) fractures were the most prevalent injury type in this region. No angiograms were done. The prevalence of the different pelvic findings is shown below in Figure 10.

Figure 10. Pelvic findings



3.3.8. Findings in the extremities

It must be noted that pan-scan rarely extends beyond the proximal femora unless otherwise indicated and/or the extremity is scanned as an angiogram. Overall, 12.5% of the patients undergoing pan-scan had at least one extremity injury. Lower limb fractures (10.4%) were the most common injury type is this region. CT angiography was performed in 10.0% (n=29) of cases with only on positive finding. The prevalence of the different findings is shown in Table 3.12 below.

Table 3.12. Findings in the extremities

Findings: Extremities	Fracture: Lower	30	10.4
	Fracture: Upper	7	2.4
	Angio done	29	10.0
	Angio positive	2	0.7

3.3.9 Other findings

Incidental findings were additionally present (39.8%) in patients who were found to also have actual injuries on pan-scan with a similar prevalence to the group that had absolutely no injuries found (39.6%). See table 3.13 below.

Table 3.13. Other findings

Positive finding	Incidental finding		
	No	Yes	Total
No	29	19	48
Yes	145	96	241
Total	174	115	289

3.4. Determination of the association between the indications versus findings/injuries by anatomical region.

Starting with the different MOI types, cross-tabulation was performed against the overall findings/injuries found on pan-scan per anatomical region.

Head region injuries demonstrated a statistically significant though weak association with::

- MVA (passenger/driver) ($p<0.0001$; phi coefficient = 0.25): In patients where this MOI was given as an indication for the pan-scan a lower proportion of head injuries was found (38.6%) compared to those without this MOI (64.1%).
- MVA (rolled/head-on collision) ($p = 0.013$; phi coefficient = 0.15): In cases where it was specified that the vehicle either rolled and/or was in head-on collision there was a lower proportion of head injuries found (23.8%) in comparison with those without this MOI (52.2%).
- MVA (pedestrian) ($p<0.0001$; phi coefficient = 0.26): Pedestrians hit by speeding motor vehicles were found to have a higher proportion of head injuries (68.8%) than those without this indication (41.3%).

Injuries in the c-spine demonstrated no significant associations to any MOI types.
No MOI types showed any significant associations to chest injuries.

Abdomen/pelvis region injuries showed statistically significant but weak, associations with:

- MVA (rolled/head-on collision) ($p = 0.021$; phi coefficient = 0.14): In cases of head-on collision or vehicle rolling, there were a lower proportion of abdomen/pelvis injuries (19.0%) in comparison with those without this MOI (46.3%).
- MVA (fall/ejection) ($p = 0.0006$; phi coefficient = 0.17): In cases where the patient had been ejected from the motor vehicle during the accident, fallen off the back of an open vehicle or a train or motor bike, there was a lower proportion of abdomen/pelvis injuries (28.6%) than in patients without this MOI (48.7%).
- MVA (pedestrian) ($p<0.0001$; phi coefficient = 0.19): Patients who collided with moving motor vehicles at high speeds had a higher proportion of abdomen/pelvis findings (58.1%) compared to those without this MOI (37.8%).

No MOI types demonstrated any significant associations with injuries in the extremities.
The rest of the indications were also correlated to injuries in the different body regions as follows:
The indication head injury showed a statistically significant but weak association with:

- Head findings/injuries ($p = 0.030$; phi coefficient = 0.13): Patients with this indication had a higher proportion of head injuries (64.7%) found on pan-scan as compared to those without it (47.1%).

The indication post laparotomy had a weak but statistically significant association with:

- Abdomen/pelvis findings/injuries ($p = 0.0002$; phi coefficient = 0.22): Patients with who had had a laparotomy prior to the pan-scan had a higher proportion of positive abdomen/pelvis findings (92.9%) in comparison to those who had not been operated (41.8%).

The indication tender abdomen demonstrated a statistically significant but weak association with:

- Head, Chest and Abdomen/pelvis injuries: Patients with this indication had a lower proportion of injuries in the regions of the head (35.3%, $p = 0.021$, phi coefficient = 0.14), the chest (49.0%, $p= 0.038$, phi coefficient = 0.13) and the abdomen/pelvis (31.4%, $p = 0.044$, phi coefficient = 0.12) as compared to the patients who did not have this indication (53.4%,65.1% and 47.1% respectively).

The indication of spine tender/deformity demonstrated statistically significant but weak associations with:

- Head, Chest, Abdomen/pelvis and Extremity Findings : Patients getting pan-scan for the indication of spine tenderness/deformity had a lower proportion of injuries to the head region (28.9%, $p<0.0001$, phi coefficient = 0.26), the chest (43.3%, $p<0.0001$, phi coefficient = 0.26), the abdomen/pelvis (32.2%, $p = 0.0071$, phi = 0.16) and the extremities (5.6%, $p = 0.020$, phi coefficient = 0.14) findings compared to those without it(49.7%, 84.4% and 15.6% respectively).

The indication of Low GCS / LOC demonstrated no statistically significant associations with injuries in any body region. The indication of obvious fractures demonstrated a statistically significant but weak association with:

- Extremity findings/injuries ($p = 0.0024$; phi coefficient = 0.20): Patients with the indication of obvious fractures had a higher proportion of extremity injuries found on pan-scan (33.3%) compared to those without it (10.3%).

The indication haematuria had a statistically significant but weak association with:

- Abdomen/pelvis region injuries/findings ($p = 0.0067$; phi coefficient = 0.16): In patients where haematuria had been given as an indication for pan-scan, there was a higher proportion of abdomen/pelvis injuries (72.7%) than in those without this indication (41.9%).

The indication of Hb dropping did not yield any statistically significant association with injuries in any specific anatomical region.
The indication of ETOH (under the influence of alcohol) did not show any statistically significant association with injuries in any particular body region.

4. Discussion

4.1. Results in context

Demographics

At CHBAH 289 pan-scans (not counting excluded cases) were performed over the 12 month period from 16/12/2015 and 16/12/2016. This is almost twice the number (140 - with children included) performed at the Metropolitan Trauma Service in Pietermaritzburg (which comprises of two hospitals) in 2012 (23). The exclusion of children in this study may account for the mean age being 33 years instead of 24 as reported by the Pietermaritzburg study. However there is a similar gender distribution. In both studies; the majority of the cases were related to motor vehicular accidents. In a similar study in Iran by Sabzghabei *et al* the mean age of the subjects was also around 34 (46).

Indications by mechanism of injury

There are variations, as well as, similarities in the frequency of MOIs reported in different studies. In this study the most common MOIs were High-velocity Motor Vehicle Accident (MVA) passenger/driver (54.7%) and MVA-pedestrian (32.2%). This is similar to what Kenter *et al* reported in Texas USA with motor vehicle collision comprising 47% of the MOI's that got pan-scan, but this is followed by motor cycle collision (13.3%) rather than MVA-pedestrian collisions (47). They report a much smaller rate of pedestrians struck by vehicles (10%) but then falls from height (10.5%) rates are significantly higher than the rate found in this study (5.9%).

Falls from height in our setting are probably less frequent secondary to our housing setting with fewer of our patients living in high rise buildings. Due to the fact that we also have high population densities and perhaps less road safety regulation compliance this may explain our higher rates of vehicle-pedestrian collisions. Bicycles are not a popular mode of transport in Soweto and this probably accounts for the lack of bicycle vehicle collisions victims undergoing pan scan. When receiving a referral stating that the patient was a pedestrian involved in a collision with a vehicle moving at high velocity, the radiologist should be alerted to the increased likelihood of craniofacial and abdomino/pelvic injuries.

Unique to CHBAH is the performance of pan-scan for mob justice. 4.5% of the patients undergoing pan-scan were referred for this indication. There was no statistically significant linkage between mob justice and particular injury types, thus this indication fails to direct the attention of the radiologist to any specific injury type and increase diagnostic sensitivity.

Indication by clinical parameters

These are the reasons that clinicians, after examination of the patient, have mentioned in motivating for the performance of a pan-scan. The most clinical examination findings resulting in request for pan-scan were low GCS/LOC (72.0%) and tenderness/step deformity of the spine (31.1%). Note that GCS score was rarely specified by value except to say it was low or high, or there was reduced level of consciousness (LOC). Perhaps it does not necessarily have to be qualified by value as according to Oosthuizen et al as long as GCS<15 this is already considered a source of unreliable clinical assessment (23).

Considering that low GCS/LOC is the most common reason for requesting pan-scan; the most common injury detected by pan-scan is not in the head and face region (50.2%) but rather in the chest (62.3%). It makes logical sense to expect a statistically significant association between this indication (Low GCSLOC) and injuries in the head region but surprisingly this was not the case. This indication may be helpful as far as bringing clinical certainty in patients who are not fully aware, but it is non-specific and fails to raise an index of suspicion for any particular injury type. When clinicians cite the indication of head injury in the referral letter, the radiologist can reasonably expect to find injuries in the craniofacial region and thus must have an increased index of suspicion.

The indication of post laparotomy yields a high positive rate in the abdominal region. This can be misleading when taking into account that this includes findings such as free air and free fluid which can be reasonably be expected. This indication does, however, prompt a careful examination of the abdomen on pan-scan and informs the radiologist to double check their findings in the case of a completely normal result in this body region with this indication cited in the referral.

Alcohol (ETOH) consumption or intoxication was cited as a reason for requesting pan-scan in 4.5% of the cases. This is comparable with the reported 5.5% and 1.8% of driver and pedestrian crash fatalities found to have blood alcohol content above the legal limit in 2015 according to The Organisation for Economic Co-operation and Development (OECD) (48). Using ETOH as an indication may be helpful and ruling out injury when the clinical examination is likely unreliable but this indication fails to raise alarms regarding any specific injury types.

Paradoxically the referrals stating that the abdomen is tender do not necessarily yield a higher proportion of abdominal injuries in our setting. This seems to point to the fact that abdomen/pelvic injuries are more likely to be detected on pan-scan when there is no abdominal tenderness. A possible reason for this could be skin injuries that will not necessarily be detailed in a radiology report. A high index of suspicion needs to be maintained.

When the referrals state that there was spinal tenderness or deformity, this did not correlate with a higher proportion of c-spine fractures or injuries in any specific body region. This is unexpected and in fact appears to point to a lower proportion of injuries in a few body regions other than the c-spine. This may be explainable on the other hand by there being spine injuries in other body regions other than the c-spine therefore diluting the sensitivity of this indication.

The radiologist must have a high index of suspicion for abdominal injuries when haematuria is an indication on the referral for pan-scan. Only 7.6% of the patients had this indication but is associated with a higher proportion of abdomino/pelvic injuries as would be expected.

Although there was no statistically significant association with vascular injuries, a dropping Hb remains an ominous sign that should not be ignored. There was not enough numbers of referrals for this indication and vascular injuries on angiography were only a few. This may explain the lack of association with injury types for this indication.

Indication by emergency room imaging

Only 41.5% of the patients referred for pan-scan had had EFAST done of which 26.3% were positive. No specific injury types demonstrated statistically significant correlation with a positive EFAST although one would have expected a strong relationship with abdominal injuries. EFAST has no ionizing radiation and can be done at the bed-side, but was omitted in 58.5% of the patients that were referred for pan-scan. This was most likely related to the skill level of the referring clinician as ultrasound is user-dependent. In the local setting a referral stating that EFAST was positive adds no value in as far as predicting likely injury types that the radiologist must take particular care to exclude.

A positive x-ray or LODOX finding was cited as an indication for pan-scan in 41.2% of the patients who had pan-scan during the study period. This would include fractures to long bones, suspicion of mediastinal widening or spine fractures. One would have expected these injury types to reflect statistically significant linkage with injuries found in the chest, long bones, aortic injuries or spine fractures. The reason for this could be the wide variation in the findings that are cited as indications for pan scan and the wide variation of the injury types being suspected.

Correlations

It was expected that certain indications would correlate positively with findings in different regions. To name but a few: head injury as determined clinically and low GCS would have been expected to correlate positively with head injuries, spine tenderness/deformity with spine injuries and abdominal tenderness and positive eFAST with intra-abdominal injuries. A number of indications had expected associations with injuries in the body regions that they implied would be injured on referral, but a few were unexpected such as MVA with ejection/fall from moving vehicle or motor bike yielding a lower proportion of pelvic injuries than other MOI's, and MVA with head-on collision/vehicle rolling yielding a lower proportion of head injuries. There are in some cases reasons for the apparent lack of expected associations and care should be taken in interpreting the results. Some of the reasons could be exaggeration of the history either by the referring clinician to get the scan done or by the patients. There is also too much arbitrary use of words on the referral form which introduces too many variables that may impact statistical significance. For example some of the forms read "requested by Prof"or "expanding haematoma" or "wall fell on him" and the list goes on.

Findings overall

Overall, there was at least one injury/positive finding in 83.4% of the patients. Despite the inconsistency of the indications in showing significant correlations with injuries in specific body regions, the indications used at CHBAH in the referral for pan-scan do detect injuries in a high number of the subjects. Whether those injuries are significant enough to influence a change in management or not is a subject for another study.

4.2. Current applications

This study serves to highlight the need for standardized referral indications (including better use of terminology) to allow better utilisation of scarce resources in the South African public trauma centres. Indications for pan-scan must be clearly set out on the referral form to help the radiologist to look out for specific injury patterns. As it stands now; there is no strong statistical correlation between the information on the referral form and injury patterns detected on pan-scan to allow the use of pan-scan to be linked to the correct patient at the right time, and to help the radiologist to accurately predict the findings to look out for, based on the information on the referral letter.

4.3. Limitations of the current study

This study had several limitations that warrant discussion. Information relating to whether the results of the pan-scan led to any clinical intervention that would otherwise have been omitted to the detriment of patient care was not obtained. Such information would require extensive review of clinical notes - an exercise demanding in resources and time which was out of reach for now.

No injury severity scores were available to enable comparison with other studies internationally.

As much as the rate at which pan-scan is performed at CHBAH is higher than is experienced in developed countries, the study started off with a gross over-estimation of the number of pan-scans that would have be assessed over a period of one year.

This is a single centre study and therefore the implications of its results cannot be as far reaching as larger multi-centre studies. Some of the results appear paradoxical whereby mechanisms of injury known and expected to yield positive findings on pan-scan appear not to do so. This has to be interpreted with care as there may be reasons for this as stated in the discussion above.

4.4. Areas for further research

It is unknown how much of the pan-scan reported findings at CHBAH actually result in action that changes the management and prognosis of the patients. A joint research project in collaboration with the trauma department may shed more light on this matter.

At CHBAH it is still unknown whether pan-scan contributes to a reduction in mortality or not, when compared to selective scanning and this would be another area of further research.

It would appear that little thought is given to the effects of radiation in the imaging of trauma patients. This remains an area for further research especially in, but not limited to, the paediatric population for whom stochastic effects have tremendous implications.

A trauma lexicon; such as that used in BIRADS for breast imaging and TIRADS for thyroid imaging should be researched to see if it can improve the use of terminology in referrals for trauma imaging in order to standardise indications for imaging and perhaps improve the predictive of value of referrals letters and ensure that pan-scan are performed on the correct patients.

5. Conclusion

At CHBAH the referral for pan-scan contains multiple varied indications. Some of the indications are similar to international guidelines as outlined in table 1.1 in the literature review. The prevalence of the different MOI's is comparable with those of other studies internationally with the main difference being the higher local rates of PVA. Some indications are unique to the local environment such as mob justice.

There are too many different indications cited for requesting pan-scan at CHBAH. These could probably be fewer and more predictive of certain injury patterns if there was a standard trauma lexicon used. These indications still lead to injuries, (however small), being detected in a large number (83.4%) of those getting scanned. This high yield could change if an analysis of the clinical significance of injuries was done - an exercise that fell outside the scope of this study.

The most common indications for which pan-scan is requested have been identified as low GCS/LOC(72.0%) and high velocity MVA (54.7%). This indication is non-specific and does not direct the attention of the radiologist reading the scan, to any particular injury type. It does not as would logically be expected predict presence of craniofacial injuries. Patients referred for PVA (32.2%) are prone to getting more injuries than all the other MOI's and other indications cited on the referral letter for pan-scan. Radiologists reading the pan-scans should therefore be alerted when receiving a referral with this indication. The most common injuries on pan-scan are in the chest region (62.3%), followed by the head (50.2%).

A few weak positive correlations provide encouragement, but for the most part the history provided does little to alert the radiologist to the possibility of specific injury types. Improving this would logically enhance the detection of injuries on pan-scan.

It needs to be emphasized that definitive life-saving treatment must not be delayed for the purpose of imaging (13). There is still a place for selective scanning targeted at areas of concern after a careful clinical evaluation.

Appendix A: Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Lefu Leshoele

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150758

NAME: **(Principal Investigator)**	Dr Lefu Leshoele
DEPARTMENT:	Diagnostic Radiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Patterns of Referral Trauma Patients for Pan-Scan at Chris Hani Baragwanath Academic Hospital (CHBAH)
DATE CONSIDERED:	31/07/2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Tebogo Hlabangana
APPROVED BY:	Professor C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	12/04/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Administrators in Room 301, 302,304,Third floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193 University of the Witwatersrand.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in July and will therefore be due in the month July each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical)

Principal Investigator Signature   Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix B: Approval by hospital management.

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 6 July 2015

TITLE OF PROJECT: Patterns of referral of trauma patients for Pan-Scan at Chris Hani Baragwanath Academic Hospital

UNIVERSITY: Witwatersrand

Principal Investigator: L Leshoele

Department: Radiology

Supervisor (If relevant): Hlabangana

Permission Head Department (where research conducted): Yes

Date of start of proposed study: July 2015
Date of completion of data collection: Dec 2016

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

Recommended
(On behalf of the MAC)
Date: 06 July 2015

Approved/Not Approved
Hospital Management
Date: 07/07/15

6. References

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