WHOLE BODY COMPUTED TOMOGRAPHY (CT PAN-SCAN) A PROPOSED GUIDELINE FOR ADULT MAJOR BLUNT TRAUMA IN MALAYSIA

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ABSTRACT:

This proposed guideline is created to assist in the development and implementation of a Whole Body Computed Tomography (WBCT) protocol for adult major blunt trauma victims attending tertiary medical centres and centres with the availability of CT-scans in Malaysia

The introduction of WBCT or CT-Pan Scan in trauma has evidently improved clinical outcomes globally by reducing morbidity and mortality rates. It provides rapid accurate diagnosis and reduces the risk of missing potentially life-threatening injuries. Integration of such intervention will reduce delay to time critical treatment and improve patient outcomes. WBCT should be performed only for selected high-risk patients. With focus on reducing risk versus benefit ratio and channelling resources to appropriate cohorts of patients, the WBCT should be performed with evidence-based triage criteria's that depict severe injuries and predict victims whom are at high risk of concealed life-threatening injuries. Protocol and indication thresholds may differ amongst institutions depending on the availability of resources and expertise. This proposed guideline may assist the proses of developing an effective protocol. It addresses confounding issues surrounding the use of WBCT and delineates the indication threshold and pre-set triage criteria's including, mechanism of injury, anatomical and physiological parameters.

This proposed guideline addresses key issues and provides the basis for the development of an effective Whole Body Computed Tomography in trauma protocol for tertiary hospitals in Malaysia. This is a clinical trauma system improvement intervention, which incorporates CT-Imaging guidelines to facilitate rapid diagnosis and reduce potentially life threatening missed injuries in major trauma.

Keywords: Trauma in Malaysia, Major trauma, Whole body computed tomography, WBCT, Trauma, CT Pan Scan

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INTRODUCTION:

Injury is a major contributor to morbidity and mortality worldwide. Each day more than 14000 human lives are lost as a result of injury. Every 6 seconds, someone in the world dies of an injury related incident. Amongst the top global causes of injury related death are road traffic accidents, suicides, falls, and homicides. Globally, Injury is the leading cause of death amongst the younger population between the ages of 15-29 year's old and road traffic accidents (RTA) is the 9th top cause of death. RTA related death is estimated to rise further to the 7th position by the year 2030[1]. This will be true in the event that there are no further critical trauma preventive and curative strategies initiated by then.

In Malaysia, Injury ranks the 5th highest cause of death in the Ministry of Health Hospitals and the 8th highest cause of death in private healthcare facilities. It is also the 4th highest cause for hospitalisation in both government and private hospitals[2]. It is estimated that 90 % of global injury related deaths occur in the low to middle income countries[1]. Malaysia falls within the bracket of a middle-income nation with RTA being the highest contributor to injury related death. In the year 2014, 5.6% of all-cause mortality in Malaysia was contributed by transport related accidents, which translated to the loss of 4304 lives[3]. An estimated 62% of transport related death's involved riders utilising 2 or 3-wheeler vehicles[4]. The National Trauma Database in 2009, and the trauma registry report of Hospital Sultanah Aminah Johor in 2012, both reported RTA, falls and assaults as being the 1st, 2nd and 3rd highest cause of major trauma amongst patients respectively[6,7].

Road traffic accidents inflict a great loss to the nation in both the aspects of structural destruction as well as human capital losses. In the year 2010, it was estimated that road traffic crashes had cost the nation to have lost 1.5% of the GDP in financial terms[5]. RTA is the 3rd highest cause of death for the population within the ages 0-14 year's old and the 2nd highest cause of death for the 15-64 year's old age bracket[3]. These age brackets consist of the nation's youth and the productive working age group. Such loses will prove to be detrimental especially so if the statistics begin to rise further with increasing number of vehicles on our roads. According to the World Health Organisation (WHO), for every death, it's estimated that there are dozens of others whom are hospitalised, hundreds of others whom present to the emergency departments and hundreds more whom are encountered by clinics and outpatient doctor appointments[8]. The psycho-social burden of injury is also detrimental to the loved ones of the victim. All in all, trauma proves to be a great burden to our society and therefore it is imminent that effective preventive trauma measures and post trauma care be implemented. The Ministry of Health Malaysia strongly promotes initiatives in improving both human resource capacity and capability in trauma expertise. Emphasis is given in initiating policies and effective clinical protocols that will benefit major trauma victims in reducing mortality and morbidity outcomes.

The introduction of the whole body Computed Tomography (CT) or CT-Pan Scan Trauma guideline is a vital step towards creating an improved trauma system management and clinical approach for major trauma victims in Malaysia. This strategy is an impactful intervention that can potentially reduce the mortality and morbidity of trauma. The WBCT for trauma guideline is designed upon a pre-set triage criteria, which includes the mechanism of injury, anatomical and physiological parameters during primary assessment of the severely injured trauma victim.

DEFINITION

The Whole Body Computed Tomography (WBCT) for Trauma

A standardized CT Scan Protocol of the vertex to the symphisis pubis that is performed for patients presenting to the Emergency Department whom fulfil pre-determined triage criteria's that meet the pre-requisites of major blunt trauma (as defined by this proposed guideline)

Selective Computed Tomography Scan for Trauma

A CT Scan imaging that is performed on a selective body region determined by the attending clinician's primary assessment of injuries sustained by a trauma victim

THE WHOLE BODY COMPUTED TOMOGRAPHY (WBCT) FOR TRAUMA

The use of WBCT in acute major trauma management was first described in Germany in 1997.[27] Since then, WBCT for trauma has been successfully incorporated as a standard protocol in many advanced trauma centres in Europe[9-13], United States[14-15], Australia[16], China[21] and Japan[17]. It is incorporated as part of the initial assessment tool for victims of major trauma. Despite conceptual similarities, the protocol varies from centre to centre[18] in relation to its indication, activation threshold as well as the WBCT protocol itself. There is unlikely to be any one protocol that will fulfil and satisfy requirements of all institutions, given that the healthcare and trauma system landscape may differ drastically from region to region. Few institutions have a formal WBCT trauma activation protocol accessible online,[16,19,20,35] but heterogeneity in the WBCT protocol is vast and therefore making it difficult to compare outcomes amongst centres[18,22].

Up to date, there is only one international, multi-centre, prospective, randomised control study comparing WBCT versus conventional and selective CT imaging in trauma, REACT-2. The study found no significant differences in in-hospital mortality for the comparison groups [24]. The REACT-2 study was plagued by the methodology which included higher number of severely injured patients in the WBCT group and that 46% of the selective CT group were sequentially scanned equalling them to receiving a pan-scan [22], inadvertently making the REACT-2 results less significant in analysing mortality outcomes but further emphasizing the importance of WBCT in major trauma. An American prospective observational study conducted by Ali Salim et al. in 2006 analysed the benefits of WBCT Protocol in trauma patients based upon their mechanism of injuries [14]. The protocol was

initiated for both conscious and reduced consciousness patients whom did not appear to have any obvious clinical signs of abdominal injury, but had experienced significant mechanism of injuries. The 18-month observation which recruited 1000 patients demonstrated the treatment for 18.9% of patients were changed due to the CT findings. The advantage of the WBCT in trauma protocol would be largely obvious to the lesser experienced primary assessment medical team than otherwise. Despite inadequate number of prospective randomised studies, the trend of heterogeneous studies point towards a greater benefit especially in reducing trauma related mortality, morbidity, Emergency Department transit time, shorter hospital stays, reduced ventilator dependant days and reduced organ failure rates [9-13,17,18,21,23,25,26,27]. The implementation of this protocol will potentially improve the injury detection rates amongst clinicians[6] and reduce the disparities of life threatening and missed injury diagnosis amongst various doctors of differing experience. The implementation of this guideline would allow injury diagnoses to be rapidly attained, enabling critical interventions to be performed with lesser delay and hence with improved outcome. WBCT in trauma will be a valuable enhancement to the Malaysian trauma health care system, taking to consideration the high volume of trauma cases in its ED attendance [6,7] versus the potential risk of under-detecting serious injuries. It will also double as a "safety-net" mechanism in reducing missed injuries as well as benchmarking a higher standard of care for trauma patients in Malaysia.

WEIGHING RISK & BENEFITS IN CREATING A BALANCED PROTOCOL

The use of WBCT needs to be weighed against the risk and benefits when advocated for trauma patients in the ED. The risks are mainly associated with excessive radiation exposure [28] and potential development of contrast induced acute kidney injury, also commonly termed as contrast induced nephropathy (CIN)[29,30]. Over scanning with low threshold guidelines would lead to excessive negative scans and unnecessary exposure to stochastic radiation induced cancer risk[28]. It is therefore important to create a guideline that would provide both benefits to the right cohort or patients while balancing the odds. The task lies in identifying patients whom would potentially benefit with high injury severity scores (ISS >15), identified from the mechanism of injury, anatomical and physiological parameters during initial assessment. It is also prudent to balance the implementation of the guideline without compromising good clinical practice of performing thorough clinical examination, against overt dependence on CT imaging interpretation[31,32,34]. The ATLS concept in managing major trauma still remains the focus. WBCT in high risk trauma patients will act as an adjunctive secondary survey tool by providing rapid and comprehensive assistance in attaining accurate injury diagnosis, especially when CT interpretations are coupled with good clinical accruement.

WBCT FOR TRAUMA RADIATION DOSE AND EXPOSURE

An effective dose of radiation from a single WBCT is between 14-22.7 mSV.[28] The WBCT radiation dose is approximately 13 mSv more than the selective CT imaging option[33]. The lifetime attributable cancer mortality risk per unit radiation dose is inversely related to age [46,38]. Studies demonstrate a rapid decrease in lifetime risk for developing cancer from first exposure with advancing age [42]. The risk of a patient dying from cancer in a single WBCT radiation dose at the age of 45 years old is approximately 1:1250 (0.08%) and 1:1700 (0.06%) if the WBCT is done at the age of 65 years old [28]. To put the data into clearer perspective, for every 100,000 population, approximately 24 people a year will succumb to death from a road traffic accident in Malaysia [39]. As of 2015, Malaysia has a population of 30,331,000 and the average life expectancy is 75 years old [40] (77 for females and 73 for males). The lifetime risk of dying in a road traffic accident in Malaysia is approximately 1.8%, considerably higher than the postulated life time radiation induced cancer death from WBCT. Therefore, it is safe to postulate, the risk benefit ratio favours the patient when WBCT is performed with prudent trauma triage criteria based on injury mechanism, anatomical and physiological parameters during primary assessment [35]. The patients will benefit from rapid and comprehensive injury identification and treatment.

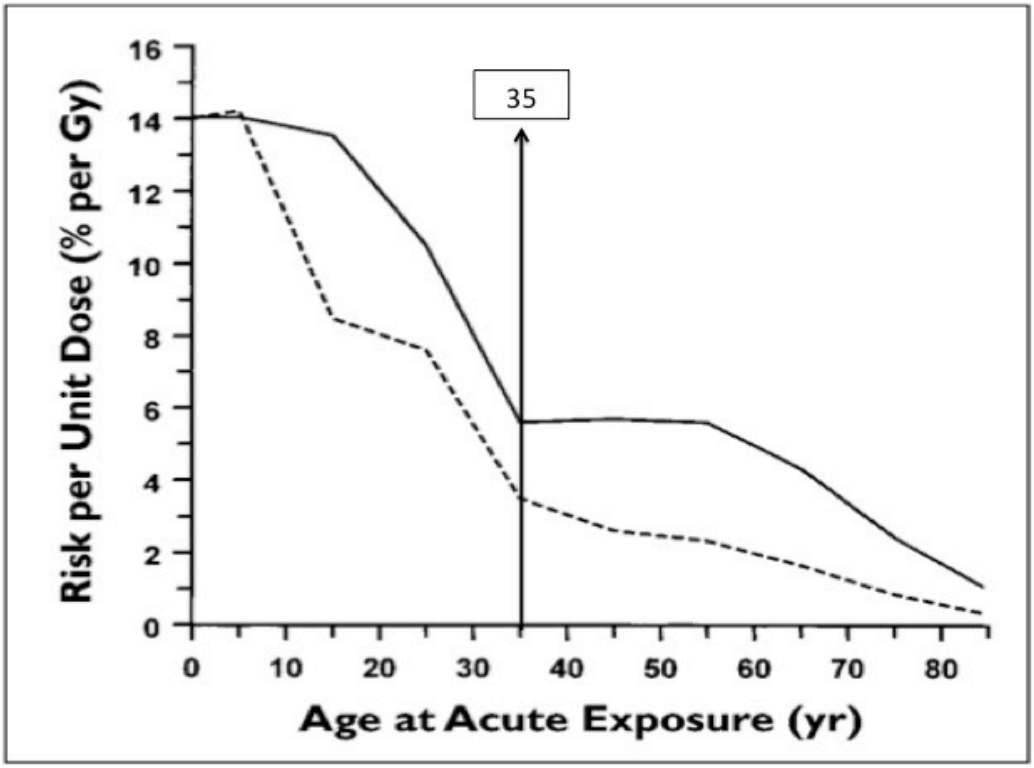

Fig.1: The above graph depicts the relationship between "lifetime attributable cancer mortality risk per unit radiation dose versus age at single acute exposure". Values reported by BEIR V and ICRP.

Solid line : National Academy of Sciences BEIR V committee (Biological Effects of Ionizing Radiations)
Dotted Line : ICRP (International Commission on Radiological Protection) report 60
← : Added vertical arrow line, demarcating the plateau phase of risk reduction after 35 y.o

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The graph above depicts a slower reduction in risk per unit dose (% of risk per Gy) evident by the plateau and reduced deceleration after 35 years old. This trend is present for both BIER V and ICRP reports. The above evidence would suggest a reduced radiation risk associated with WBCT when it is prescribed to adults above 35 years.

WBCT FOR TRAUMA AND CONTRAST INDUCED ACUTE KIDNEY INJURY (AKI)

The WBCT for trauma is commonly performed together with an iodinated contrast load. It is believed that the contrast medium may potentially pose a risk of inducing acute kidney injury which is popularly termed as contrast induced nephropathy (CIN). Delaying the WBCT for renal function is not practical in the setting of acute trauma. Typically, the WBCT for trauma would require the administration of 100-150 mls of intravenous contrast bolus [20]. The worry of developing acute kidney injury may be further exacerbated by underlying hypovolemia from haemorrhage in the trauma cohort of patients. In one study, Vassiliu P et al demonstrated 5% of 100 hypotensive patients that underwent angio embolization for visceral related injuries developed biochemical evidence of acute kidney injury. The AKI had shown to resolve in all of the 5% of patients within 5 days with post contrast hydration [35,36]. In another study, 6.6% amongst 1184 trauma patients developed biochemical evidence of post traumatic AKI. The administration of intravenous contrast was shown to not have a significant impact on AKI in this group of patients [29,35,37]. There is growing school of evidence to suggest advancing age (>65) and increasing injury severity (ISS>15) are independent predictors of acute kidney injury in trauma patients. Uni-variate and multi-variate analysis suggest that contrast dose is not associated as an independent predictor of acute kidney injury in trauma [29,37]. Evidence therefor suggest that contrast enhanced WBCT in acute trauma does not increase the risk of acute kidney injuries and the benefits of this rapid comprehensive diagnostic imaging modality outweigh the risk [37].

SPECIAL POPULATION CONSIDERATION

Paediatrics Patient

The Malaysian Department of Statistics reported, in the year 2014, 4.5% (202) of all-cause mortality for the paediatric age group (0-14 years old) was caused by transport related accidents. This value is opposed to 9.1% (3632) for the adults aged between 15-64 years old [3]. The incidence of death from major trauma amongst the paediatric population is far less compared to the adult population. It is preferred that paediatric major trauma be managed by an advanced or tertiary centre in order to ensure the best survival outcome. There is particular concern that CT scan in the paediatric trauma population yields less critical information that alters the management of the patient. This is compounded with the disadvantage of subjecting the child to an increased risk of mortality from cancers in later age [43].

Reports from two large studies which evaluated outcomes of abdominal CT findings in blunt paediatric trauma showed >70% of paediatric CT scans requested were reported as normal [44,45]. Another study demonstrated that only <5% of paediatric patients with abnormal CT Abdomen findings underwent surgical exploration [43]. There is also clear evidence that there is a tendency of over-scanning in the paediatric trauma group [35]. There is a preferred trend towards conservative care in managing blunt traumatic injury in the paediatric age group, making the CT scan seem a much less of an urgent imaging requirement tool.

The lifetime attributable cancer mortality risk per unit dose reduces with exposure at advance age and vice versa. This is attributed to the inverse relationship of radiation dose to organ with advancing age [46]. The risk of a child dying from cancer at first exposure to CT scan is higher than an adult undergoing the similar CT scan imaging. Frush et al [41] estimated that 1 in every 1000 paediatric CT examinations will lead to a cancer related mortality. Brenner et al in 2001 estimated the lifetime cancer mortality risk attributable to radiation is 1:1500 (0.07%) for a CT Head and 1:550 (0.18%) for a CT abdomen if performed on a 1-year old child [42]. This ratio is significantly higher for CT scan attributable cancer risk in the adult group. Evidence suggest that it would not be appropriate to initiate a standard trauma WBCT protocol based on triage criteria for the paediatric population. The risk versus benefit is unjustified. For the purpose of this guideline, we define the paediatric age group as 0-16 years old. Selective CT scans are preferred in this age group and only be prescribed with clear clinical indications after careful analysis of benefits versus risk is performed. Focus Assessment Sonography for Trauma (FAST) is a valuable adjunct for initial assessment and triaging with some studies suggesting more than 95% predictability rate for requirement of surgery in the paediatric age group[47].

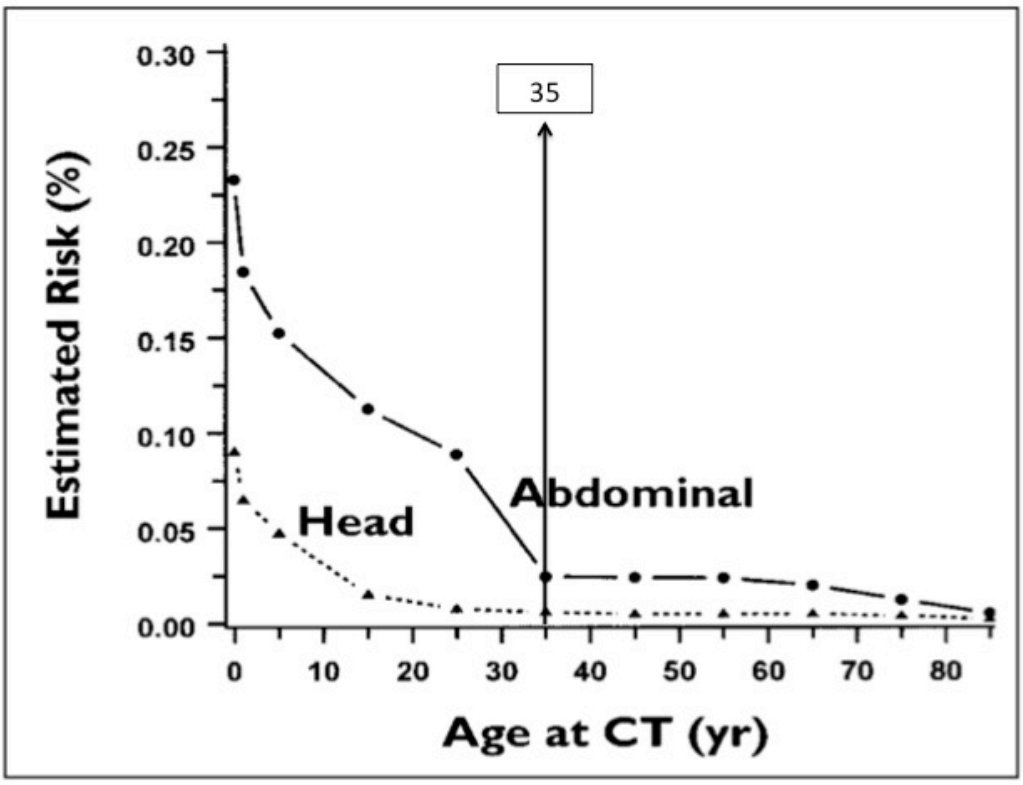

Fig. 2: The graph demonstrates "The estimated lifetime attributable cancer mortality risk versus age" at first exposure to CT examination of head (broken dotted line) and abdomen (broken solid line). Note: Rapid increase risk with decreasing age.

⟵ **:** Modified added vertical line, demarcating the plateau phase of risk reduction after 35 y.o

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Pregnant Patients

The incidence of maternal death from trauma is relatively low in Malaysia. According to the Report on The Confidential Enquiries into Maternal Death by the Ministry of Health Malaysia, there is an average of 7.7 maternal deaths a year which resulted from trauma for the years 2003-2011 [54].

The pregnant trauma patient commonly poses a challenge to both the radiologist and the attending clinician. Aside from the challenging task of managing both the mother and the foetus, issues usually revolve over the radiation risk associated with imaging modalities such as X-Rays and CT-Scans. Nevertheless, it is worth noting that the main aim and focus should be to stabilise the mother, keeping in mind that maternal demise will lead to foetal

demise [48]. Clinicians commonly worry that the ionising radiation from CT scan and X-Rays can potentially cause foetal anomalies, especially when such imaging is conducted during early trimesters. Such challenges are commonly faced in the initial assessment of the blunt trauma pregnant patients. It is worthwhile to note that absorbed foetal radiation doses of less than 50 mGy are not associated with any increased risk of foetal anomalies or foetal loss throughout the entire period of pregnancy [49,50,51]. It is also comforting to know that such threshold is well above the foetal radiation absorbed dose in all commonly required diagnostic trauma imaging modalities. A CT-scan of the head, chest, abdomen and abdo-pelvis is estimated to cause foetal radiation absorption dose of 0 mGy, 0.2 mGy, 4 mGy, and 25 mGy respectively [52,53]. A WBCT protocol would essentially be less than 30 mGy. In the event that the foetus is exposed to 50 mGy of absorbed radiation, evidence suggest that the estimated relative risk of a fatal childhood cancer is doubled from a baseline of 1:2000 (0.05%) to 1:1000 (0.1%) and the child will have an overall lifetime risk of 2% for developing cancer. In the event of a major trauma, it is therefore safe to subject the pregnant mother for either both, a selective CT or a WBCT trauma protocol. CT scans are sensitive and specific imaging modalities in diagnosing pregnancy-specific injuries such as uterine ruptures and placental abruptions[48].

Geriatric Patients

The geriatrics population defined by the age > 65 years old pose a unique challenge to the attending clinician when presented with blunt trauma. The aged population are much frailer and studies suggest that this group of population tend to sustain a disproportionate number of injuries, an increased injury severity and 10 folds increase mortality rates when compared to the younger population with the similar mechanism of injury [55]. Special attention to detail is required in the assessment of the elderly trauma victim. The general clinical and classical manifestations of a specific injury may be absent, and presentations of injuries may vary as compared to the younger patient. It is therefore not only practical to subject this group of patients for WBCT but to also ascertain a lower threshold for prescribing this imaging modality for them. Concerns of acute kidney injury from contrast enhanced CT imaging have been addressed, and studies had demonstrated that the acute kidney injury is contributed by the advancing age and injury severity rather than the contrast[29,37].

TRIAGE CRITERIAS FOR WBCT IN BLUNT TRAUMA

Amongst the major challengers in creating the guideline for WBCT is to be able to create strategic select criteria's as a triage tool for performing WBCT in blunt trauma victims. This also involves creating a balance between over scanning and under detecting clinically significant injuries. The ideal manner would be to triage the patients using ISS scores > 15 (Indicative of major trauma) but such criteria would not be practical. The ISS scores are commonly scored retrospectively. Therefor it is prudent to search for pre-hospital and initial assessment triage tools that would be able to predict higher injury severity scores[58].

Studies have demonstrated that utilising individual parameters such as, physiological markers, anatomical injury description or mechanism of injury on it's own are not adequately sensitive and specific for this purpose as compared to combining either two or more criteria categories as a decision tool [56,57]. Studies also demonstrate that physiologic criteria's provide the highest predictive yield then followed by anatomic description and mechanism or injury in predicting injury severity[2]. The clinician should also take extreme ages as an important element in triaging for WBCT.

PROPOSED TRIAGE CRITERIAS FOR WBCT IN ADULT MAJOR BLUNT TRAUMA

For all adults presenting with major blunt trauma, WBCT Is performed when there is a minimum total of at least 2 following criteria. The indication criteria need to be derived from at least 2 out of 3 categories, namely anatomical, physiological and mechanism of injury. The triage criteria predict blunt trauma victims with potential severe injuries whom would benefit from a WBCT [16,35,58].

Physiological Criteria (Upon Arrival in Emergency Department)

I. Spo2 < 90%
II. GCS < 13
III. Systolic Bp < 100 mmHg
IV. Respiratory Rate <10/min or >30/min
V. Pulse Rate > 120/min
VI. Age > 65 Years Old
VII. Anticoagulant Therapy

Anatomical Criteria

I. Visible Injury To > 1 Body Region (Head/Neck/Thorax/Abdomen/Pelvis /Long Bones)
II. Suspected Unstable Pelvic Fracture
III. Flail or Open Chest Wound
IV. Hard Signs of Spinal Cord Injury
V. Positive FAST (Focus Assessment with Sonography for Trauma)

Mechanism of injury Criteria

I. Fatality in the Same Vehicle
II. Ejection Out of The Car
III. Vehicle Roll Over
IV. Pedestrian, Cyclist, Motorcyclist vs Car (equivalent or larger vehicle)
V. Suspected Fall > 3 Meters
VI. Prolonged Extrication > 15 Minutes
VII. High Speed Collision > 50 km/h at Impact
VIII. Explosion

WBCT For Trauma in Various Age Groups

WBCT is not routinely performed for the paediatric age group population. This is predominantly attributed to the high radiation induced cancer risk, which poorly justifies the benefits gained from a triage criteria based paediatric WBCT protocol. Ultrasound or selective CT imaging should be considered based upon clinical indications.

In the young adult population (16-35 years old), prudent clinical discretion should be advocated in prescribing WBCT. Although evidence suggest that radiation induced cancer risk are far less than the paediatric population, clinical decision should be focused on the potential benefits of the

WBCT in a case to case basis. The radiation risk for this age group is significantly lower than the paediatric population but still mildly higher than the > 35 years old age group (refer: fig.1 and fig.2). Decision should be guided by the criteria's proposed and the attending clinician's clinical risk assessment. WBCT should be performed if clinically suggestive of potentially altering subsequent management. Selective CT imaging can be considered as an alternative.

The risk of radiation plateaus after the age of 35 years, and suggests that radiation risks versus WBCT benefit ratios are best for these population age group. The risk of mortality from trauma is higher in the ageing population [55,59], inversely the risk of radiation reduces [38,42,46]. The WBCT triage criteria's can be utilized to assist clinicians in prescribing WBCT for high-risk blunt trauma patients within these age groups.

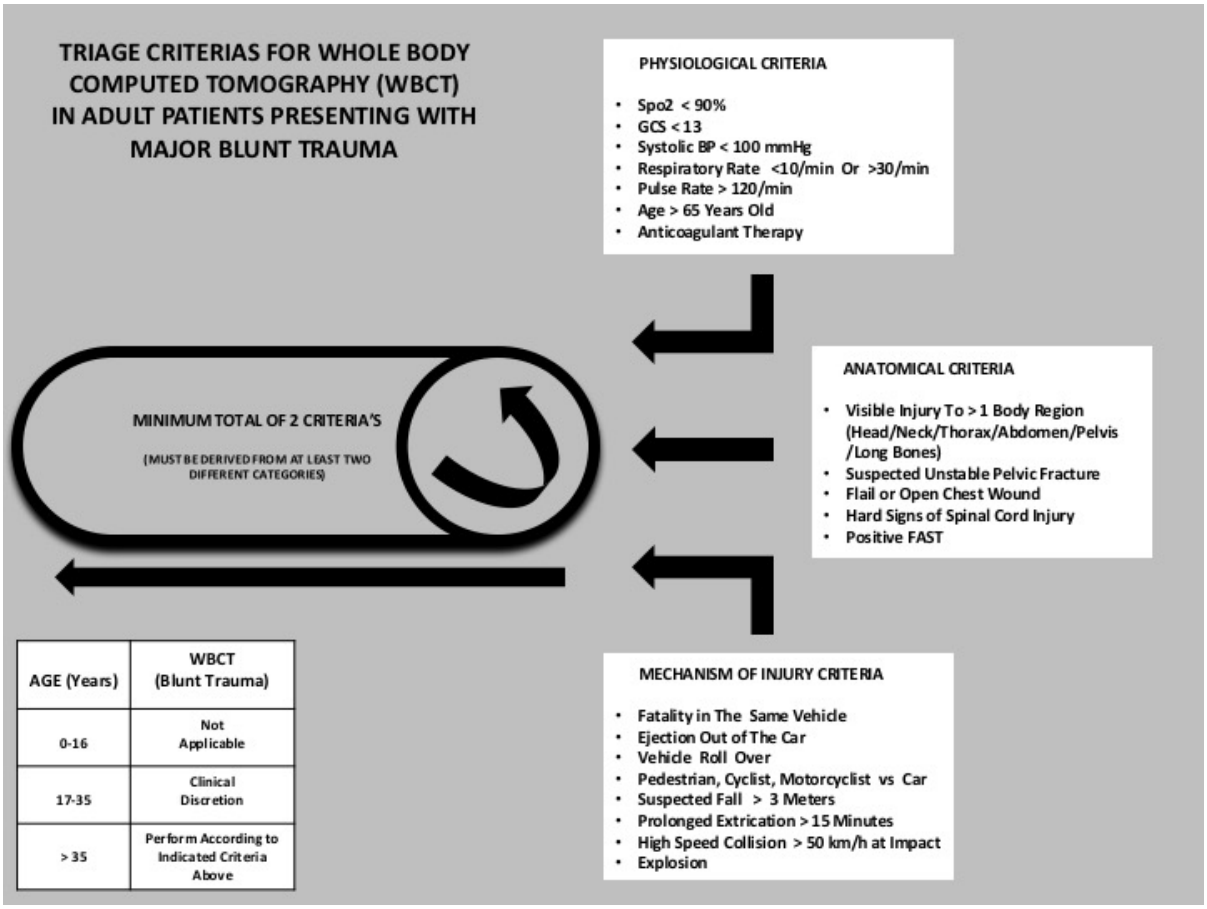

Fig.3: Proposed Whole Body Computed Tomography Triage Criteria for Adult Major Blunt Trauma Victims in Malaysia

WBCT SCAN PROTOCOL

The WBCT Scan should be performed with emphasis on risk reduction measures. The doses utilized should be in line with the principles of ALARA (As Low as Reasonably Possible) consistent with the diagnostic task.

RADIOLOGY REPORTING [20]

The CT reporting should be performed in a fashion that allows for clinical management prioritisation, balancing a rapid yet comprehensive report. It should be delivered in the primary and secondary survey format.

Primary Survey Report

Is a preliminary radiology report indicating the presence of any major life threatening injuries which would require emergency interventions to be performed immediately. Report Interval Time; Handed over to the Trauma Team Leader immediately after WBCT is performed

Secondary Survey Report

Is a definitive radiology report of all present injuries interpreted from the WBCT imaging. This report should be validated by the Radiologist on duty. Report Interval Time; Within 1 hour from completion of WBCT

SAFE TRANSFER OF PATIENT FROM EMERGENCY DEPARTMENT TO WBCT SUITE

The Team Leader and members of the trauma resuscitation team is responsible to ensure that the transfer of the patient for WBCT is performed in a safe and seamless manner.

Following are key considerations that should be addressed;

Airway	Patient has a protected or secured airway
Breathing	Adequate breathing & ventilation
	Spo2 > 94%
Circulation	All external haemorrhages secured
	Use Pelvic Binder (unless and only if there Is presence of clinical or radiological evidence to suggest no unstable pelvic fractures)
	Systolic blood pressure maintains > 90 mmHg
	Heart rate maintains > 50/min and < 120 /min
	Minimum of 2 functioning large bore IV access (minimum 18G - green) or equivalent (intra-osseous access)
Disposition	Patient transfer is led by personnel trained in trauma life support
	The route chosen should be the shortest and safest, taking into consideration of any emergency contingency interventions that may be required
Etiquette	Minimise risk and delay with a pre-existing work flow process between Radiology and Emergency Department team

Table.1: Critical factors in ensuring safe and seamless transfer of patient from the Emergency Department to the WBCT suite

RELEVANCE OF PRIMARY SURVEY X-RAYS

In this proposed guideline, the WBCT is advocated as an adjunct to the secondary survey. In the opinion of the authors, it is reasonable for the primary survey X-rays (Chest and Pelvis) to be omitted in patients that have been decided for WBCT at an early phase. Such can be done with the following conditions;

I. Clinical assessment by a specialist indicates that there is no imminent compromise on the airway,

breathing and circulatory component

II. The WBCT procedure can be performed within 30 minutes and all measures in Table.1 are advocated

III. The Patient is accompanied by a fully equipped team (monitoring and resuscitation devices), including a medical doctor trained in trauma life support

INCORPORATING WBCT IN THE EMERGENCY DEPARTMENT TRAUMA RESUSCITATION ALGORITHM

Most Emergency Departments have readily existing protocols on the management and clinical work flow of major blunt trauma victims. The processes are widely influenced by the recommendations placed forward by the Advanced Trauma Life Support (ATLS) Guidelines Committee, American College of Surgeons. The WBCT would be an adjunct to the secondary survey for hemodynamically stable blunt trauma victims. After arrival to the ED, initial assessment and resuscitation would be initiated simultaneously. The clinician will then be able to gauge the clinical direction of the patient. Hemodynamically unstable blunt trauma victims whom require immediate surgical haemorrhage control will undergo continues damage control resuscitation and damage control surgery. WBCT will be performed for hemodynamically stable patients whom are at high risk of severe injuries. This assessment will be based upon fulfilling the WBCT triage criteria. The patients who do not fulfil criteria's will be subjected to alternative imaging protocols, such as selective CT imaging, ultrasounds or X-Rays.

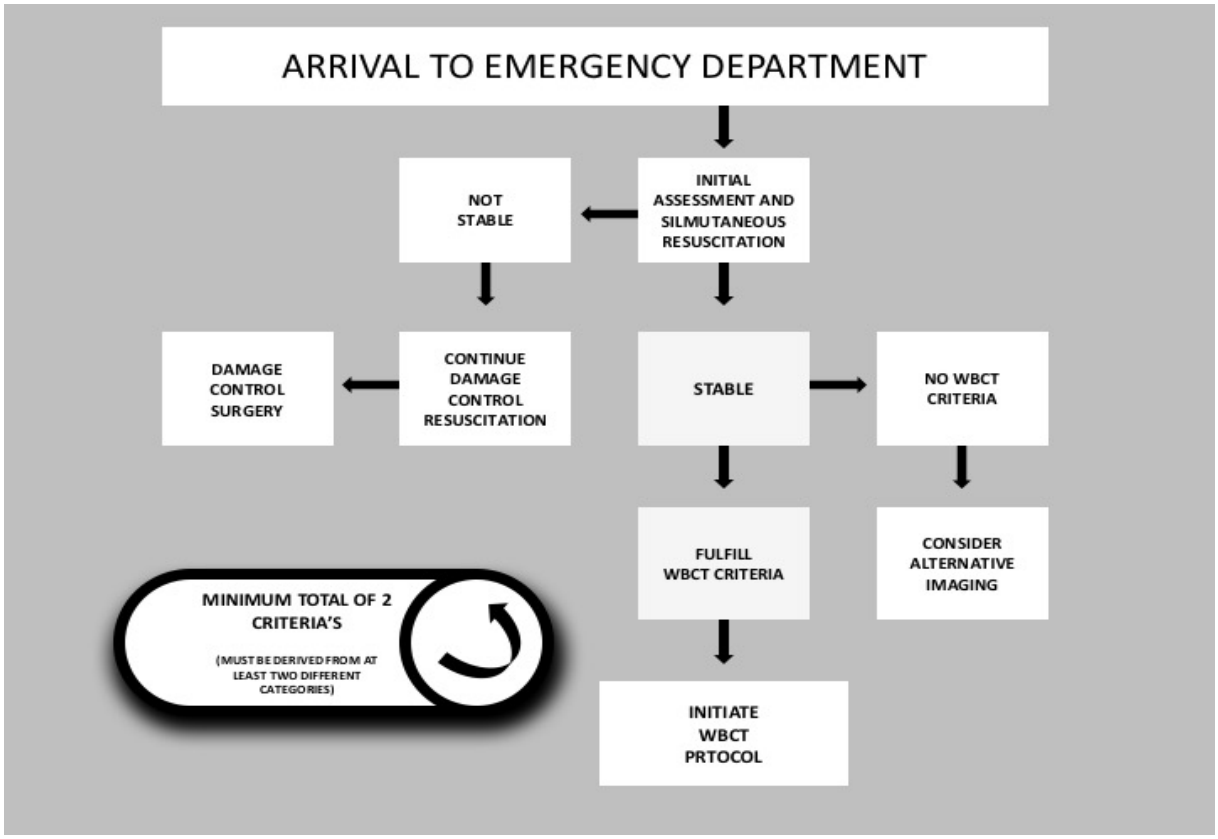

Fig.4: Incorporating WBCT Into the Clinical Pathway of Emergency Department Trauma Resuscitation.

CONCLUSION

This proposed guideline addresses key issues and provides the basis for the development of an effective Whole Body Computed Tomography in trauma protocol for tertiary hospitals in Malaysia. This is a clinical trauma system improvement intervention, which incorporates CT-Imaging guidelines to facilitate rapid diagnosis and reduce potentially life-threatening missed injuries in major trauma. The authors acknowledge the heterogeneity of resources and clinical services amongst medical institutions. In order to successfully integrate WBCT services within a medical facility, certain adaptations to this proposed guideline may be required. Adaptations should take into consideration, the focus on safety, rapidness of performing WBCT, selecting appropriate indication criteria to reduce incidence of missed injuries and ensuring that the benefits outweigh the disadvantages for the patient.

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