Diagnostic yield, safety, and outcomes of whole-body CT scans in post-arrest care

Key Article

- *Branch KRH, Gatewood MO, Kudenchuk PJ, et al. Diagnostic yield, safety, and outcomes of Head-to-pelvis sudden death CT imaging in post arrest care: The CT FIRST cohort study. Resuscitation. 2023;188:109785.*

Background

- Post-CA challenges: limited history, etiology of arrest is often unknown, and it's often challenging to make clinical decisions to address the underlying cause.
- Guideline-based standard of care includes ECG, CXR, blood tests, head CT, and post-arrest echocardiography.
    - Recently, the European Soc. Of Cardiology has suggested adding a chest CT when an obvious cause of arrest isn't identified by initial testing.
    - Additional CT scans are largely at the discretion of the treating physician
- In trauma patients, protocolized "pan-scans" have been widely accepted in severe trauma.
    - In fact, the evidence suggests that in severely injured trauma patients, whole body CT scans can identify a significant number of clinically important injuries that would have been missed by physical exam alone, and result in a change in treatment for a number of patients.
- After cardiac arrest, a CT protocol including a "pan-scan" plus a coronary CT may allow for a faster diagnosis for the cause of arrest and reduce delays in treatment.

Objective: To compare the standard of care alone to the addition of a whole-body CT scan (authors termed a sudden death CT) within 6 hours of hospital arrival.

Methods

- Observational study of OHCA patients with ROSC that compared a historical control group (called the SOC-cohort) against a cohort from a previously study published in 2021 in the Academic Emergency Medicine journal.
    - *SOC-cohort:* Received institutional standard of care diagnostic testing (January 2014 – Dec 2015), which commonly included post-arrest EKG, head CT, and echo.
    - *CT cohort:* Received standard of care PLUS head-to-pelvis CT (Dec 2015 – Feb 2018)
        - This cohort was from a previously published 104 patient observational study in Academic EM (Branch KRH, Strote J, et al. Early head-to-pelvis computed tomography in out-of-hospital circulatory arrest without obvious etiology. Acad Emerg Med. 2021.)
        - **This previous study found that:**
            - Early pan-CT identified potential causes of arrest in 39% of idiopathic OHCA patients.

- In addition, 40% of patients were identified to have critical findings or resuscitation complications which included liver/spleen lacerations, pneumothorax, and hemorrhagic complications.
- Pan CT exclusively identified 13 (13%) OHCA causes that would otherwise not be identified without SDCT imaging.
- AKI was common (28%) but only one (1%) patient required new dialysis.

- Post-arrest care protocol was the same between groups during the 4-year study period
- Location: Both cohorts of patients were cared for at 2 academic hospitals in the Seattle Washington area
- Patients
  - Inclusion Criteria
    - Adults aged $\geq$ 18 years old
    - Successful resuscitation from OHCA without an obvious cause
    - Could undergo the sudden death CT protocol within 6-hours of ROSC
  - Excluded patients:
    - Obvious cause of cardiac arrest
    - Indication for emergent invasive coronary angiography
    - Known obstructive coronary disease with a previous PCI/stent
    - Known defibrillator
    - Known pre-existing DNR order
    - Relative exclusion: Known severe renal dysfunction – exclusion for the pan CT cohort
- Sudden Death CT protocol (included 3 scans)
  - Non-contrast head CT
  - Thoracic CT with an ECG-gated a coronary angiogram
  - Venous phase, non-ECG gated abdomen and pelvis
- Causes for OHCA: adjudicated after patient discharge by two physicians with access to the medical records
- **Primary outcome:** the diagnostic yield of the Sudden Death CT protocol compared to the standard of care to identify the cause for the OHCA event.
- **Secondary Outcomes:**
  - Time to adjudicated OHCA cause
  - Diagnosis of a time critical diagnoses by SDCT compared to standard of care
  - Incidence of delayed diagnosis to time critical diagnosis (> 6 hrs)
  - Safety measurements after SDCT scan (AKI by 48 hours, allergic reactions, or CT complications such as extravasation, unintentional extubation, etc.)

Results

- Patients
  - 247 total patients were included in the study
    - SOC cohort: 143
    - SDCT cohort: 104
  - Well matched for age, gender, race, and comorbidities
  - Approximately 60% of patients were witnessed arrests in both groups, and the initial rhythms (VT/VF, Asystole, PEA) were also similar
  - Significant difference in bystander CPR between cohorts:
    - 58% in the SDCT cohort
    - 40% in the historical control/Standard of care cohort

- **Primary outcome:** the combination of SDCT and the SOC identified 92% of presumptive causes for OHCA compared to 75% of patients by SOC alone (p: < 0.001).
- **Secondary Outcomes**
    - The SDCT protocol was associated with faster diagnosis (3 hours vs. 14 hours)
    - Decreased incidence of delayed time critical diagnosis (12% in SDCT vs. 62% in SOC)
    - Similar survival to hospital discharge and rates of acute kidney injury

Limitations Identified by the Authors

- Lack of randomization
- A number of the patients in the SOC group received at least 1 type of CT scan
- Lack of blinding for the adjudicators determining the cause for arrest could have biased the authors.

Author conclusions:

- The sudden death CT protocol added to the post-OHCA standard of care early after ROSC by improving the time and diagnostic ability to determine the cause of OHCA.
- The SDCT protocol did not improve survival

Other articles of interest:

Adel J, Akin M, Garcheva V, et al. Computed-tomography as first-line diagnostic procedure in patients with out-of-hospital cardiac arrest. *Front Cardiovasc Med*. 2022;9:799446.

Tables for reference

Table 2 – Procedures performed during hospitalization.

	SDCT-cohort (*n* = 104)	SOC-cohort (*n* = 143)	P-value
Procedure	*N (%)*	*N (%)*	
Any CT scan (contrast or non-contrast)	104 (100%)	120 (84%)	<0.0001
CT head	104 (100%)	116 (81%)	<0.0001
CT chest	104 (100%)	52 (36%)	<0.0001
CT abdomen	104 (100%)	26 (18%)	<0.0001
Mechanical CPR device	28 (27%)	25 (17%)	0.06
Targeted temperature management	77 (74%)	105 (73%)	0.91
Electrocardiogram	104(100%)	143 (100%)	—
Echocardiogram	72 (69%)	96 (67%)	0.90
Coronary angiogram	31 (30%)	30 (21%)	0.11
Brain MRI	37 (36%)	51 (36%)	0.82

CT = computed tomography, CPR = cardiopulmonary resuscitation, MRI = magnetic resonance imaging, SDCT = sudden death computed tomography, SOC = standard of care.

Table 3 – Adjudicated OHCA Etiology.

Etiology (final diagnosis)	SDCT-cohort (*n* = 104)	SOC-cohort (*n* = 143)
Diagnosable by SDCT	*N (%)*	*N (%)*
Myocardial infarction	14 (13%)	18 (13%)
Pulmonary embolism	5 (5%)	3 (2%)
Aortic dissection	0 (0%)	1 (1%)
Pneumonia	9 (9%)	4 (3%)
Heart failure	6 (6%)	12 (8%)
Valvular	2 (2%)	0 (0%)
Embolic cerebral vascular accident	0 (0%)	4 (3%)
Hemorrhagic cerebral vascular accident	2 (2%)	3 (2%)
Abdominal catastrophe	3 (3%)	1 (1%)
Not Diagnosable by CT		
Asthma	5 (5%)	4 (3%)
Overdose-alcohol	5 (5%)	4 (3%)
Overdose-drugs	18 (17%)	34 (24%)
Seizure	6 (6%)	1 (1%)
Electrolyte	6 (6%)	4 (3%)
Other	15 (14%)	12 (8%)
Not specified	0 (0%)	2 (1%)
Unknown Etiology	8 (8%)	36 (25%)

SDCT = sudden death computed tomography, SOC = standard of care.

Table 4 – Primary and Secondary Outcomes.

Outcome	SDCT-cohort (*n* = 104) *Median (IQR) or N (%)*	SOC-cohort (*n* = 143) *Median (IQR) or N (%)*	Unadjusted p-value	Adjusted p-value*
Primary Outcome				
Identified diagnosis for OHCA†	96 (92%)	107 (75%)	<0.0001	0.001
Secondary Outcomes				
Time to diagnosis (hours)	3.1 (1.4,12.9)	14.1 (2.2, 69.5)	<0.0001	<0.0001
Identified time-critical diagnosis	33 (32%)	34 (24%)	0.16	0.33
OHCA diagnosis by any CT scan†	39 (39%)	24 (17%)	—	—
Delayed ascertainment (>6hrs) of time critical diagnosis‡	4/33 (12%)	21/34 (62%)	<0.0001	0.001
Survival to hospital discharge	44 (42%)	63 (44%)	0.78	0.50
Safety Outcomes				
Acute Kidney Injury	27 (26%)	34 (24%)	0.69	—

† The SDCT-cohort included likely OHCA diagnoses identified by the SDCT scan protocol as well as the SOC. SDCT diagnosed an OHCA cause exclusively in 30 (30%) of patients. Time critical diagnoses include myocardial infarction, pulmonary embolism, aortic dissection, pneumonia, embolic CVA, hemorrhagic CVA, and abdominal catastrophe. ‡Delayed clinical ascertainment of time critical diagnoses by >6 hours from arrival. *Data were adjusted for age, sex, initial rhythm, and witness status using linear regression statistical modeling. Acute kidney injury defined as >0.3 mg/dL or >50% increase in creatinine from baseline to maximum 48 hour reading.[16] CT = computed tomography, OHCA = out of hospital circulatory arrest, SDCT = sudden death computed tomography, SOC = standard of care.

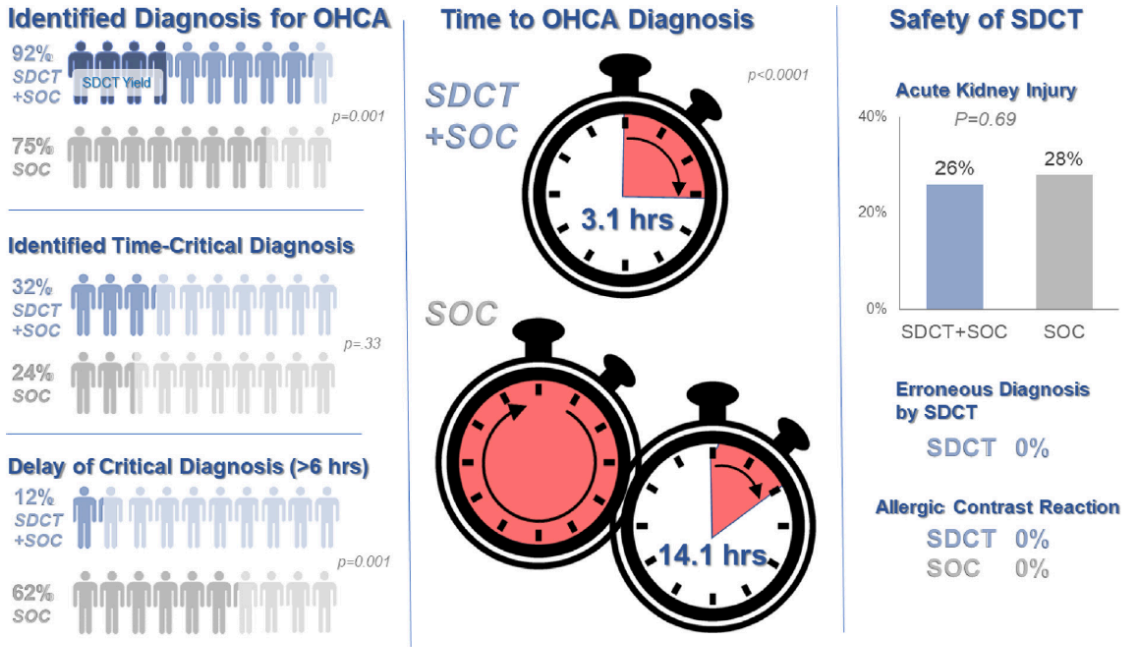

Fig. 2 – Primary outcome of diagnostic yield to identify a diagnosis for the cause of OHCA (including the overall SDCT diagnostic yield of 38%). Secondary outcomes were time to diagnosis, number of delayed critical diagnosis greater than 6 hours, and safety of SDCT-cohort compared to SOC-cohort. OHCA = out of hospital cardiac arrest, SDCT = sudden death computed tomography, SOC = standard of care.