**Supplementary Table 1- Implementation findings extracted to the Proctor (2013) Framework**

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| **Name the strategy** | **Define the implement-ation component** **and any discrete components operationally** | **The actors - detail who enacts the component** | **The action - specify the specific actions, steps, or processes that need to be enacted** | **Action target - Identify unit of analysis for measuring implementation outcomes** | **Temporality - Specify when the component is used** | **Dose - Specify dosage of implement-ation component** | **Justification (References reporting implementation components)** | **Implementation outcome affected** |
| **Pre- AVS**  Developing technical skill | ▪Number of procedures available in the centre ▪Having the right technical support  ▪Training | Hospitals or healthcare centres  Radiologists Experts in the procedure | Hospital requires a minimum number of procedures available through referral pathways annually.  Developing AVS technical expertise required needs a training program, support, positive reinforcement, opportunities for review of past procedures | Success or failure of AVS as noted by:  a) cannulation of both veins  b) sufficient blood samples  c) lack of vein or gland rupture  d) lack of adverse outcomes | ▪Hospital review of AVS volume and outcomes, as to referral to other centres.  ▪Acquiring technical experience both before and during the procedure.  ▪a training program | ▪Hospitals- minimum 15-20 AVS annually;  ▪Clinicians doing AVS need 25-30 procedures annually once the learning curve has been reached to maintain their skills | 22,24,26,27, 34-41 | Keeping the number of operators to a minimum (Low volume hospital- one operator 21,22,29,30,36; large hospital or specialised centre 1-2 operators34,35) increases the successful completion of AVS with **fidelity**  AVS referrals need to be regular and sufficient enough for a **sustainable** AVS service that has a radiologist who has maintained their learning curve |
| **Pre- AVS**  CT imaging | ▪As part of workup to rule out malignancy;  ▪ Provide the anatomy of the right adrenal vein ▪ Not for identifying subtype of PA | Radiographer Radiologist to interpret the results | A thin-slice; contrast enhanced CT is recommended. Contrast is not always routine and may need to be requested. Contrast is helpful in the location of the right adrenal vein against other anatomical features | Staff emotional state: e.g. frustration reduced; reduced fluoroscopy time; anatomy awareness; use in procedure planning | Very close in time to the AVS procedure | Once, prior to AVS. May be undertaken at other times also, such as during the patient work up or in the early diagnostic phases | 26,27,30-32,35,37 | Doing a CT scan routinely prior to AVS can increase the successful cannulation of the right adrenal vein and enhances the **fidelity** of the AVS test 21,22,26,30,32.  While CT imaging can be **costly** for the patient (particularly those with no health insurance), omitting this step however can have consequences for the procedure (time in theatre) particularly for clinicians developing their expertise in the procedure  Guidelines recommend all patients have a CT 21, however clinicians may not need the CT to guide their practice should they be sufficiently skilled22 and is therefore not **appropriate**. Using imaging alone to determine if AVS is needed is not **appropriate** 27, 32. |
| **Pre- AVS**  Patient voice and informed choice | ▪Providing appropriate information at a level patients can understand. ▪Comprehensive engagement that includes discussions about post procedure options | Referring clinician Radiologist? Other specialist | Conversations should happen often Clinicians should determine if their clients want a surgical cure before recommending or conducting AVS. Patients should be aware that the procedure may need to be repeated | ▪Information given during meeting with clinician | Information needs to be provided often with an increase in frequency before the procedure | Unsure from the data | 22,24,29,34, 38 | AVS is a day procedure that requires highly skilled personnel such as intervention radiologists to conduct 33, making it a **costly** test. Patients also need time off work to do the test which has an economic cost. |
| **Pre- AVS**  AVS suitability and procedure preparation | ▪Using workup strategies as defined by most recent guidelines ▪Not only using imaging for clinical decision making | ▪Clinicians ▪Patients (compliance and ability to participate in the work up) | Unsure from the data | ▪Use of guideline/ protocol for work up ▪Justification for non-use | As selected by the clinician as needed | When indicated by the clinician | 22-24,38 | The work up and confirmatory tests must be relevant and **appropriate** to the patient |
| **Pre- AVS**  Protocol – local hospital availability | A local AVS operation protocol is needed | ▪All participants involved in AVS should be involved in writing of the hospital protocol ▪Radiology, pathology, and endocrinology | A consultation process and a hospital working group to write the protocol. The protocol should be widely known, easy to locate, and informative for clinical decision making | * A local hospital protocol is available * The protocol is known and the steps are followed * Processes are available to ensure new staff are aware of the protocol | Implementation of a protocol will benefit future AVS conduct, enhancing consistency | N/A | 24,25,36,37, 40 | All relevant staff across departments need to agree and use the protocol which demonstrates **penetration** within the hospital system |
| **During AVS**  Rapid Cortisol Testing | Many rapid cortisol tests exist. Some measure cortisol in serum or plasma from blood samples providing a total cortisol reading requiring a lab to conduct the test. A point of care test that omits a lab is available but only measures if cortisol levels are high or not. Both tests are used to determine the successful cannulation of adrenal veins during AVS | Interventional radiologist | For plasma/serum tests- The serum is dispatched to the lab which then rapidly returns the results in less than an hour. For point of care testing, this is done at the bedside with results in minutes. | * Use of rapid cortisol testing The amount of times that it has supported the re-cannulation of the adrenal vein to prevent a failed result * Support with the learning curve of the radiologist | After the cannulation of both the left and right adrenal vein. | Once per vein | 24,26,30,33, 35-37,39 | Point of care and serum cortisol tests are an additional **cost** but confirm the correct cannulation of the adrenal veins. The consequence of not doing this test however is a repeated procedure which patients may not accept. The cost is therefore cheaper than a repeated AVS procedure and more **appropriate**. |
| **During AVS**  Cone beam Computer Tomo-graphy (CBCT) | CBCT is an alternative to rapid cortisol testing telling the radiologist about the correct catheter placement | The radiologist | Conduct of the CBCT is as recommended | CBCT is used when indicated | During the procedure to confirm the cannulation of the right adrenal vein | As needed where CBCT is used an alternative and undertaken | 30,35 | Hospitals and/or radiologists need to decide if is the CBCT the most **appropriate** or best option for patients if rapid cortisol testing is not an option  Hospitals should consider if there are enough high quality36 CBCT machines for it to be **feasible** to ensure that a scan can be done in a timely manner |
| **During AVS**  Communi-cation and collabor-ation | Different systems of communication contribute to the effective production of AVS results | The radiologist The lab technicians In theatre support staff  Referring clinician | * Between the lab and the theatre, labelling, specimen handling procedures are critical * Templates for results need to be easily understandable * Agreements between the lab and the radiologist should be made to determine reporting standards e.g. absolute values | Use of communication pathways  Development of a system between departments that is mutually agreeable | As needed | As needed | 28,34,35,40 | Communication and collaboration must be viewed as **acceptable** and a willingness to **adopt** new systems that enhance the production of AVS results needs to be evident for all stakeholders. |
| **During AVS**  Procedural support | Expert presence available during AVS to support trainees in developing their AVS expertise | An experienced AVS clinician (usually interventionalist radiologist) | Supervision and guidance intra-procedurally to provide training and offer strategies for success | Confidence and abilities of trainee to independently perform AVS | This is necessary during the learning curve phase and can become more distal as expertise develops | The learning curve is 25-30 procedures. Having expert support during each session is needed, then can taper off | 24,26,31 | Having in procedure support for learning clinicians, enhances the **feasibility** of the hospital’s AVS program and **fidelity** of the AVS procedure. It may also increase the **adoption** of the procedure by new clinicians which in turn supports the **sustainability** of the program |
| **Post AVS**  Results interpre-tation | Using clinical judgment to make decisions about AVS results | Clinician | ▪ Understanding of guidelines and their advice on result interpretation, undertaken by a multidisciplinary team  ▪ Clinicians need to use their expertise and experience in managing PA  ▪ This should be paired with a clear understanding of guidelines and evidence-based advice on AVS result interpretation | ▪ Use of protocols and guidelines or justification for not using these  ▪ Application of clinical experience  ▪ Centre-specific predetermined selectivity and lateralisation indices  ▪ Engagement with multidisciplinary colleagues to enhance diversity of views | Post AVS | After every AVS | 22,23,28,32, 34,37 | The clinical expertise, multidisciplinary team and guideline advice must be **appropriate** to the patient and their AVS lateralisation and selectivity scores. |