A Systems Approach towards Intra-Arterial Management of Acute Ischemic Stroke: Need for Novel Outcome Measures and a Focus on Sequence rather than Steps

B.K MENON¹, M. GOYAL^{1,2}

¹ Department of Clinical Neurosciences, ² Department of Diagnostic Imaging, University of Calgary, Calgary Stroke Program; Calgary, Canada

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Summary

In this editorial, we seek to focus attention of neurointerventionists and stroke physicians towards a systems approach to the intra-arterial management of acute ischemic stroke. We highlight the need to pay attention to the overall sequence and workflow of a neurointerventional procedure rather than individual steps. We also stress the importance of novel outcome measures in analyzing procedural efficacy when managing patients with acute ischemic stroke.

“Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house”.

Henri Poincare, Science and Hypothesis, 1905

Recent advances in endovascular stroke devices have resulted in significant improvement in recanalization rates¹⁻⁵. In addition, there is a trend towards reduced procedure time (first angiographic run to recanalization time)⁶. This increase in procedural efficacy has not been accompanied by a similar improvement in clinical outcome⁷. In fact, progression is a time-dependent phenomenon and reducing “stroke symptom onset to recanalization time” is critical in achieving good clinical outcomes⁸. Improving the procedural efficacy of endovascular devices therefore has to be balanced with a similar focus on improving procedural efficacy and process oriented steps antecedent to “groin puncture”. This would include reducing interval

times from stroke symptom onset to arrival in ER, to initial imaging, to intravenous tPA and to arrival in the angiography suite⁹. It would also include optimizing process-oriented steps like drip and ship, patient selection based on clinical and imaging variables, availability of a 24/7 “on call” neuro-interventional team, quick access to critical care and anesthesia services¹⁰⁻¹².

Neuro-interventionists have a tendency to get excited about the latest device that is more efficient, potentially safe and easier to use. Industry has a tendency to design studies that focus on procedural efficacy after groin puncture as this helps not only in obtaining regulatory approval for the devices but also succeeds in engaging the stroke and neuro-intervention community. Even though the treating physician realizes that time from stroke symptom onset to recanalization is of paramount importance, the focus on newer devices is, in our opinion, at the expense of a seeming lack of focus in trying to design and implement an optimal work flow pattern that will help in achieving the goal of shortest time from symptom onset to recanalization. Acute ischemic stroke management is a stochastic process with numerous sequential steps leading to the final outcome. The focus needs to shift from improving single steps in this sequence, to designing strategies that will result in an optimal sequence of steps resulting in best clinical outcomes. Improving clinical outcomes in acute ischemic stroke needs a change in the way we approach the problem. This “systems”

approach to the problem is different from the present “reductionist model” in acute ischemic stroke management, where treating physicians and industry focus on improving one step without paying much attention to the overall workflow. A reductionist approach may work if small teams focus on improving each step and the result is an improvement in the overall workflow. This approach, however, will falter if there is inordinate focus on one or two steps at the expense of others; or if improvement in one step is to the detriment of some other steps or to the overall workflow. An example of the former is when a strong focus on improving recanalization rates and puncture to recanalization times happens without focusing on other process oriented steps, like type of anesthesia employed or optimal blood pressure management¹³. An example of the latter is when advances in multimodal imaging, instead of helping in decision-making, prolong time to endovascular intervention, not reflected in published cohort studies¹⁴. MRI-based imaging paradigms provide better estimation of core, and perfusion imaging provides better hemodynamic data than NCCT. However, these imaging modalities have to be used in appropriate patients and not be a blanket imaging tool for all patients. It is common knowledge that a patient with a major stroke with early ischemic changes on CT +/- hyperdense MCA sign is an appropriate candidate for early reperfusion. Multimodal imaging may delay time to reperfusion and not provide any significant additional information for clinical decision-making in such patients. Another example of the latter is when reduction in time from stroke symptom onset to arrival results in a paradoxical delay in thrombolysis without the treating physician being aware of it¹⁵.

In endovascular interventions, inordinate focus is on increasing recanalization rates, at the expense of a lack of focus on puncture to first reperfusion time. In addition, efforts to reduce time from onset to arrival in ER, by educating the emergency medical service¹⁶ and time from ER arrival to needle by having a 24/7 on call stroke service and a 24/7 CT adjacent to the ER are rarely given attention, even though they could potentially result in reducing time from symptom onset to recanalization as much as efforts at improving multimodal imaging or mechanical devices. In our opinion, the focus of the stroke and neuro-interventional community should be on overall process management with an effort to understand the best possible inter-

mediate steps that would result in optimal workflow, appropriate patients and the shortest time to recanalization. This would entail designing clinical trials where intermediate steps like “on call” management, design of ER and proximity to CT, choice of imaging modality, drip and ship vs single hospital treatment, per-procedural management and post procedure disposition would all be recorded and analyzed as important variables responsible for predicting clinical outcome. We believe that designing such clinical trials is the need of the hour. Study results, instead of showing variables that predict good clinical outcomes using a regression analysis, must in addition show an optimal process that would achieve best clinical outcomes. This requires standardizing definitions for each process in an overall workflow and reporting these processes accordingly. In the endovascular management of acute ischemic stroke, we feel that reporting the following “time” intervals and process may be standard, and peer reviewed articles and editors could insist on the same. These are:

1. Onset of imaging (CT or MR) to groin puncture.
2. Total imaging time (time from putting patient on imaging table to getting them off the table).
3. Groin puncture to first reperfusion.
4. Total puncture to reperfusion time.
5. Order of mechanical devices and reperfusion rates with each device.
6. Final reperfusion grade.

This would require neuro-interventionists and stroke physicians being assiduous in data collection. Maintaining a comprehensive national or international registry of patients undergoing endovascular procedures in acute ischemic strokes could serve this purpose. The danger of believing our experiences and taking a heuristic approach to treatment is not scientific. Efforts towards setting up such a registry will improve understanding of treatment paradigms and workflow, and help neuro-interventionists and stroke physicians in designing and using holistic strategies to improve clinical outcomes in patients presenting with acute ischemic stroke.

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Dr Mayank Goyal, MD, FRCPC
Seaman Family MR Research Center,
Foothills Medical Center, 1403
29th St NW, Calgary, AB
Canada T2N 2T9
Tel.: 1-403-9443379
Fax: 1-403-2707907
E-mail: mayank.goyal@albertahealthservices.ca