Developing competency frameworks and increasing accessibility for Clinical Movement Analysis Society UK & Ireland (CMAS) accreditation

Report for CMAS small grant award

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Contents

1 Overview

The Clinical Movement Analysis Society UK & Ireland (CMAS) is a registered charity (1148105), formed to encourage professional interaction, develop and monitor operational standards and training, and to stimulate and advance scientific knowledge in the fields of clinical motion analysis. Accreditation, is an essential part of this, which allows for quality assurance regarding professional standards and training. A Standards Working Group (Committee) was established in 2001 to ensure good practice through development of standards alongside education and training.

Currently there are 15 CMAS accredited laboratories (labs) across the UK and Ireland. There is a significant need to increase access to motion-analysis labs for both the upper and lower limbs in order to improve our understanding of disease processes and allow for better planning in surgery and rehabilitation. Whilst advances in the quality and availability of measurement technology and associated software's, have enhanced our ability to measure and understand human movement, a major barrier is the availability of motion-analysis labs which are structured to provide clinically useful information. Despite motion-analysis becoming more accessible through the emergence of new technologies and methods of collecting, processing and reporting clinical movement analysis data, the number of CMAS accredited labs has remained fairly consistent.

Improved accessibility to motion-analysis labs could improve patient outcomes across multiple health domains. In order to facilitate increased access to motion-analysis labs it is important to support more labs in getting their accreditation. This can be achieved by identifying existing competencies and similarities in good practice across already accredited CMAS labs. It is important to raise the profile of how these competencies can be met and disseminate this information widely so that more labs will try to get accreditation. It is also important to recognise that evaluating and consolidating practice across all labs allows for examples of good practice to be shared and made accessible to other CMAS accredited labs.

2 Report aims

The aim of this project was to develop recommendations for a competency framework and supporting documents to make the application for CMAS accreditation clearer and more accessible in order to support more motion-analysis labs in getting CMAS accreditation. The recommendations of this preliminary report will be presented at a CMAS consensus meeting for discussion. Two main work packages were carried out in order to address the requirements of this report

Work Package 1 - Data collection for CMAS labs **competencies and documentation**

- Clinic managers/representatives of CMAS labs were contacted to request copies of documentation relevant to competencies
- Where required and able, clarification was sought for instances in which competency documentation and evidencing required further clarification
- The deliverables of this work package were collated documentation for all CMAS labs, outlining processes used for determining and recording competencies

Work Package 2 – Description (mapping) of existing competencies and development of recommendations for a draft competency frameworks and reference documents

- A mapping exercise was completed, identifying individual lab competencies and processes surrounding them using a conventional content analysis approach
- Similarities in practice were identified from which recommendations regarding generic competency framework and reference documents could be generated
- These were classified and aligned with the CMAS Standards Document 20 November 2020 i.e. categories regarding patient history taking, clinical examination, data collection, data interpretation, scope of clinical recommendations
- The deliverables of this work packages are the current preliminary summary report to be presented at a CMAS consensus meeting for discussion 1) outlining current practice and methods used for determining

and recording competencies in CMAS accredited labs and 2) recommendations for a competency framework and supporting documents to make the application for CMAS accreditation clearer and more accessible in order to support more motion-analysis labs in getting CMAS accreditation.

3 Scope and limitations of this report

This report has been written on the basis of information that was available and sent to the author(s). Therefore, the information contained within the report reflects the information that was explicitly stated in the Statement of Purpose documents (updated as of May 2021) of individual labs and information extracted from competency documents provided. Individual labs may therefore have tacit knowledge of additional information regarding competency and accreditation processes or standards not disclosed in this report. It is hoped that individual labs will have an opportunity to review the information contained within this report for accuracy prior to wider dissemination outside of CMAS.

This report is not meant as a replacement for existing documentation which outlines the requirements for new labs seeking CMAS accreditation[1] and auditing of standards for CMAS accreditation[2]. Given that CMAS already has existing documentation for accreditation and ensuring compliance with standards, these have not been replicated here. Similarly, it is recognised that in addition to CMAS accreditation standards, labs and associated staff may be subject to additional requirements of their trust, national regulatory[3] and professional bodies[4] which are independent of CMAS standards for accreditation. These have not been replicated here. Where possible, this report has sought to identify processes of documenting competency which are aligned to the aforementioned documents and processes. However, in some instances this was not possible owing to limited or no access to the required documentation e.g. BS7000.

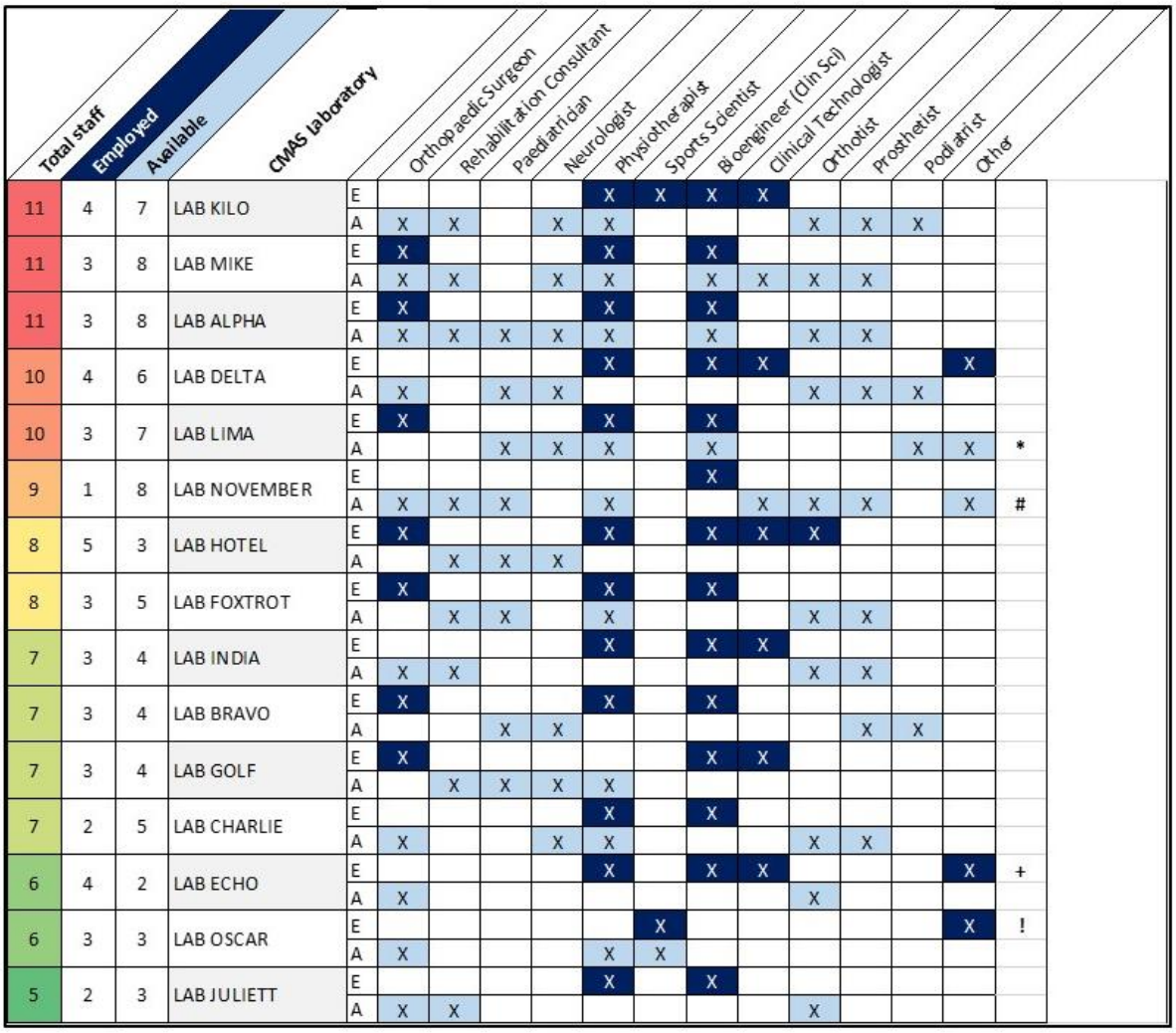
At the time of writing this report, all labs were CMAS accredited and therefore met the standards for accreditation.

[1] CMAS Accreditation for New Labs Version 14.
[2] CMAS Audit Checklist Version 14.2
[3] UKAS, BS7000, ISO13458, ISO9001, MPACE
[4] HCPC, Clinical Scientist Training Pathway

4 Summary of CMAS Labs

There are 15 labs with CMAS accreditation. The information for all labs is contained within this report, including two labs who recently obtained CMAS accreditation during the writing of this report. An overall summary of the staff profiles (employed by the labs and available for consultation) are available in figures 1 and 2. The overall number of staff employed and available for consultation across CMAS labs is likely reflective of the clinical services available/offered. The mean (SD) number of staff employed was 3 (1) and the mean (SD) number of staff available for consultation was 5 (2).

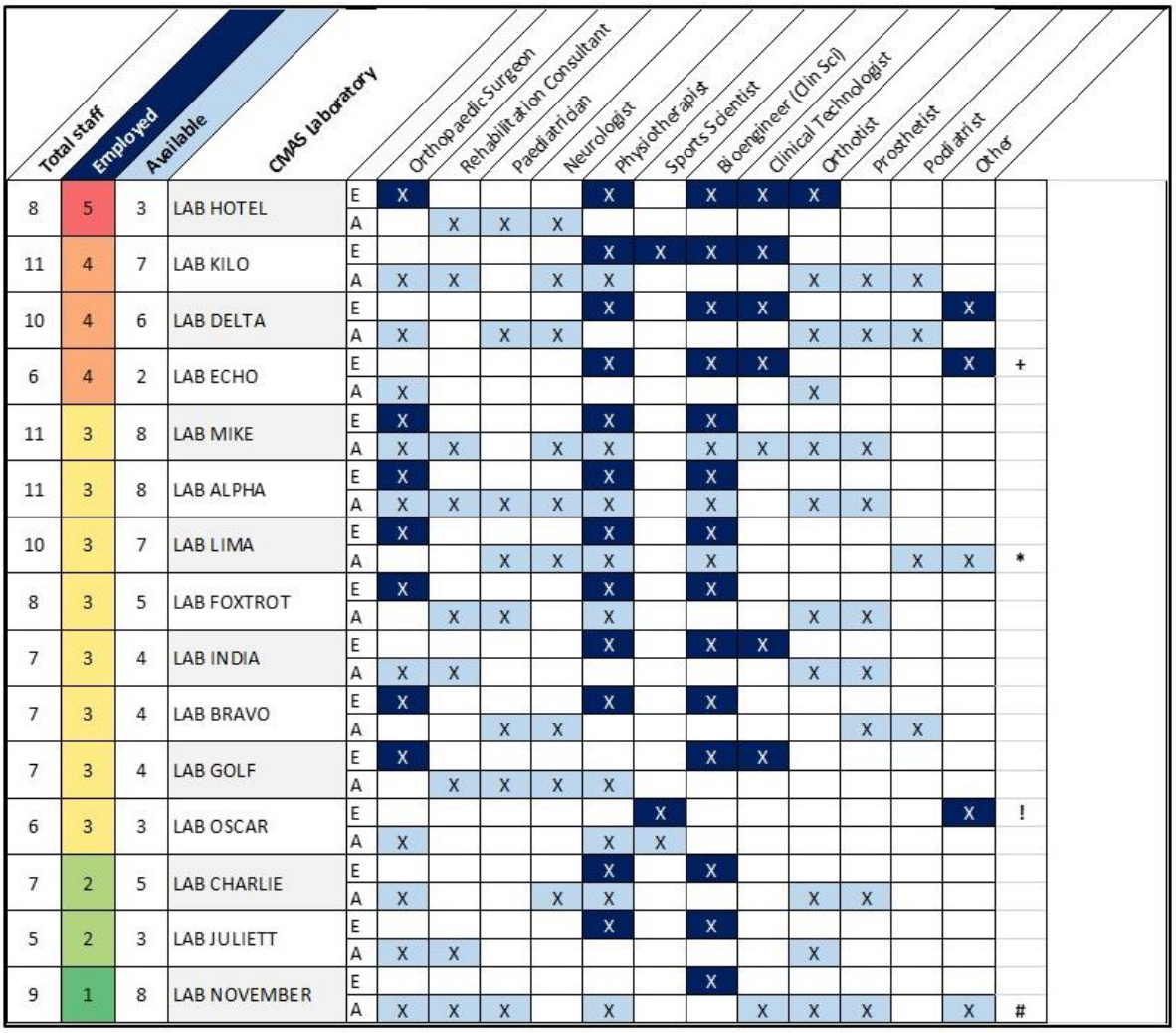
Figure 1. Staff profiles of CMAS labs ranked in descending order by total number of staff



Total staff	Employed	Available	CMAS laboratory		Orthopaedic Surgeon	Rehabilitation Consultant	Paediatrician	Neurologist	Physiotherapist	Sports Scientist	Bioengineer (Clin Sci)	Clinical Technologist	Orthotist	Prosthetist	Podiatrist	Other	
11	4	7	LAB KILO	E				X	X	X	X						
				A	X	X		X	X				X	X	X		
11	3	8	LAB MIKE	E	X			X		X							
				A	X	X		X	X		X	X	X	X			
11	3	8	LAB ALPHA	E	X			X		X							
				A	X	X	X	X		X		X	X				
10	4	6	LAB DELTA	E				X		X	X					X	
				A	X		X	X				X	X	X			
10	3	7	LAB LIMA	E	X			X		X							
				A			X	X		X				X	X	*	
9	1	8	LAB NOVEMBER	E						X							
				A	X	X	X	X			X	X	X		X	#	
8	5	3	LAB HOTEL	E	X			X		X	X	X					
				A		X	X	X									
8	3	5	LAB FOXTROT	E	X			X		X							
				A		X	X	X				X	X				
7	3	4	LAB INDIA	E				X		X	X						
				A	X	X						X	X				
7	3	4	LAB BRAVO	E	X			X		X							
				A			X	X					X	X			
7	3	4	LAB GOLF	E	X					X	X						
				A		X	X	X									
7	2	5	LAB CHARLIE	E				X		X							
				A	X			X				X	X				
6	4	2	LAB ECHO	E				X		X	X					X	+
				A	X							X					
6	3	3	LAB OSCAR	E					X							X	!
				A	X			X	X								
5	2	3	LAB JULIETT	E				X		X							
				A	X	X						X					

*Rheumatologist & Oncologist; # Neurosurgeon; + Support worker; !Senior research officer & Clinical biomechanist
E = employed by lab; A = available for consultation

Figure 2. Staff profiles of CMAS labs ranked in descending order by total number of employed staff



Total staff	Employed	Available	CMAS Laboratory		Orthopaedic Surgeon	Rehabilitation Consultant	Paediatrician	Neurologist	Physiotherapist	Sports Scientist	Bioengineer (Clin Sci)	Clinical Technologist	Orthotist	Prosthetist	Podiatrist	Other	
8	5	3	LAB HOTEL	E	X				X		X	X	X				
				A		X	X	X									
11	4	7	LAB KILO	E					X	X	X	X					
				A	X	X		X	X				X	X	X		
10	4	6	LAB DELTA	E					X		X	X				X	
				A	X		X	X					X	X	X		
6	4	2	LAB ECHO	E					X		X	X				X	+
				A	X								X				
11	3	8	LAB MIKE	E	X				X		X						
				A	X	X		X	X		X	X	X	X			
11	3	8	LAB ALPHA	E	X				X		X						
				A	X	X	X	X	X		X		X	X			
10	3	7	LAB LIMA	E	X				X		X						
				A			X	X	X		X				X	X	*
8	3	5	LAB FOXTROT	E	X				X		X						
				A		X	X		X				X	X			
7	3	4	LAB INDIA	E					X		X	X					
				A	X	X							X	X			
7	3	4	LAB BRAVO	E	X				X		X						
				A			X	X						X	X		
7	3	4	LAB GOLF	E	X						X	X					
				A		X	X	X	X								
6	3	3	LAB OSCAR	E						X						X	!
				A	X				X	X							
7	2	5	LAB CHARLIE	E					X		X						
				A	X			X	X				X	X			
5	2	3	LAB JULIETT	E					X		X						
				A	X	X							X				
9	1	8	LAB NOVEMBER	E							X						
				A	X	X	X		X			X	X	X		X	#

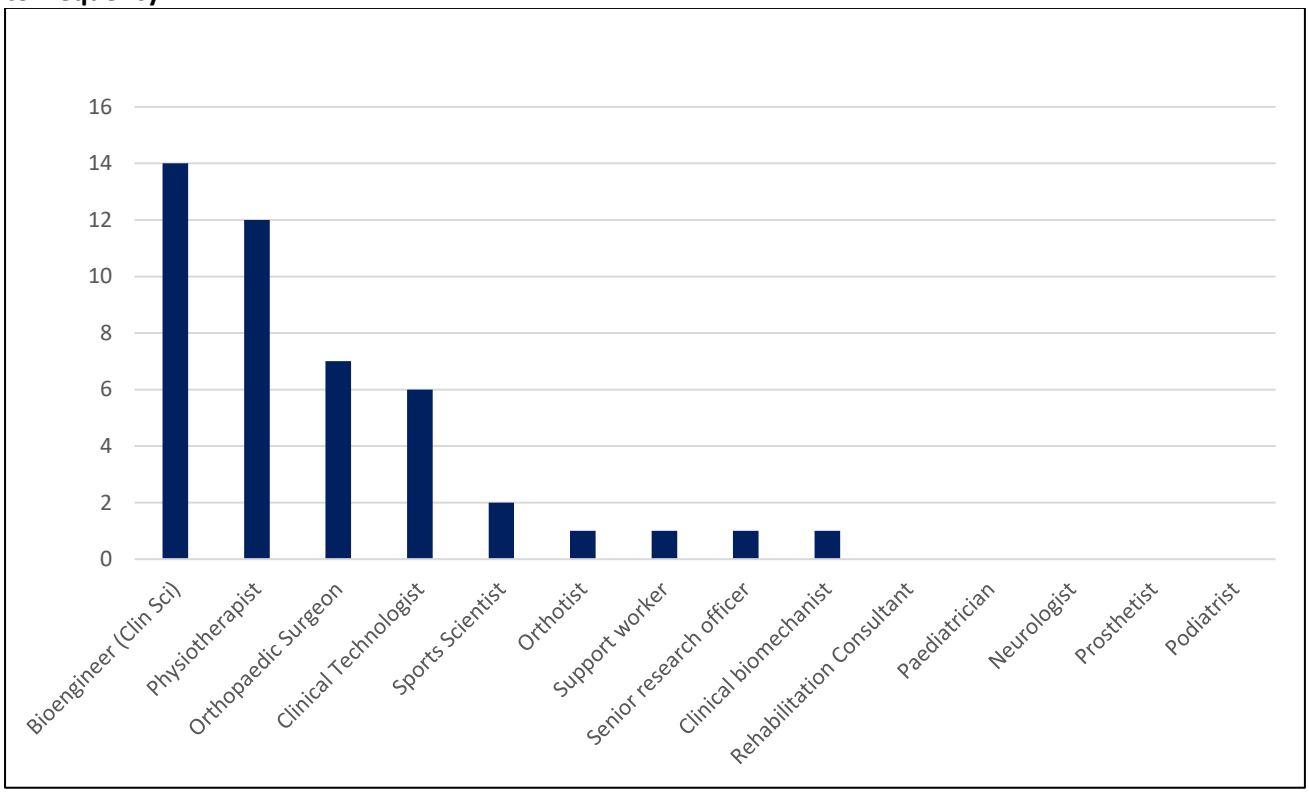
An overview of the profiles of professional disciplines employed across CMAS accredited labs are presented in figures 3 and 4.

Figure 3. Profiles of professional disciplines employed across CMAS accredited labs

	Orthopaedic Surgeon	Rehabilitation Consultant	Paediatrician	Neurologist	Physiotherapist	Sports Scientist	Bioengineer (Clin Sci)	Clinical Technologist	Orthotist	Prosthetist	Podiatrist	Other	
LAB ALPHA	X				X		X						
LAB BRAVO	X				X		X						
LAB CHARLIE					X		X						
LAB DELTA					X		X	X					
LAB ECHO					X		X	X				X	+
LAB FOXTROT	X				X		X						
LAB GOLF	X						X	X					
LAB HOTEL	X				X		X	X	X				
LAB INDIA					X		X	X					
LAB JULIETT					X		X						
LAB KILO					X	X	X	X					
LAB LIMA	X				X		X						
LAB MIKE	X				X		X						
LAB NOVEMBER							X						
LAB OSCAR						X						X	!

[+] Support worker; [!]Senior research officer & Clinical biomechanist

Figure 4. Professional roles employed across CMAS accredited labs ranked in descending order according to frequency



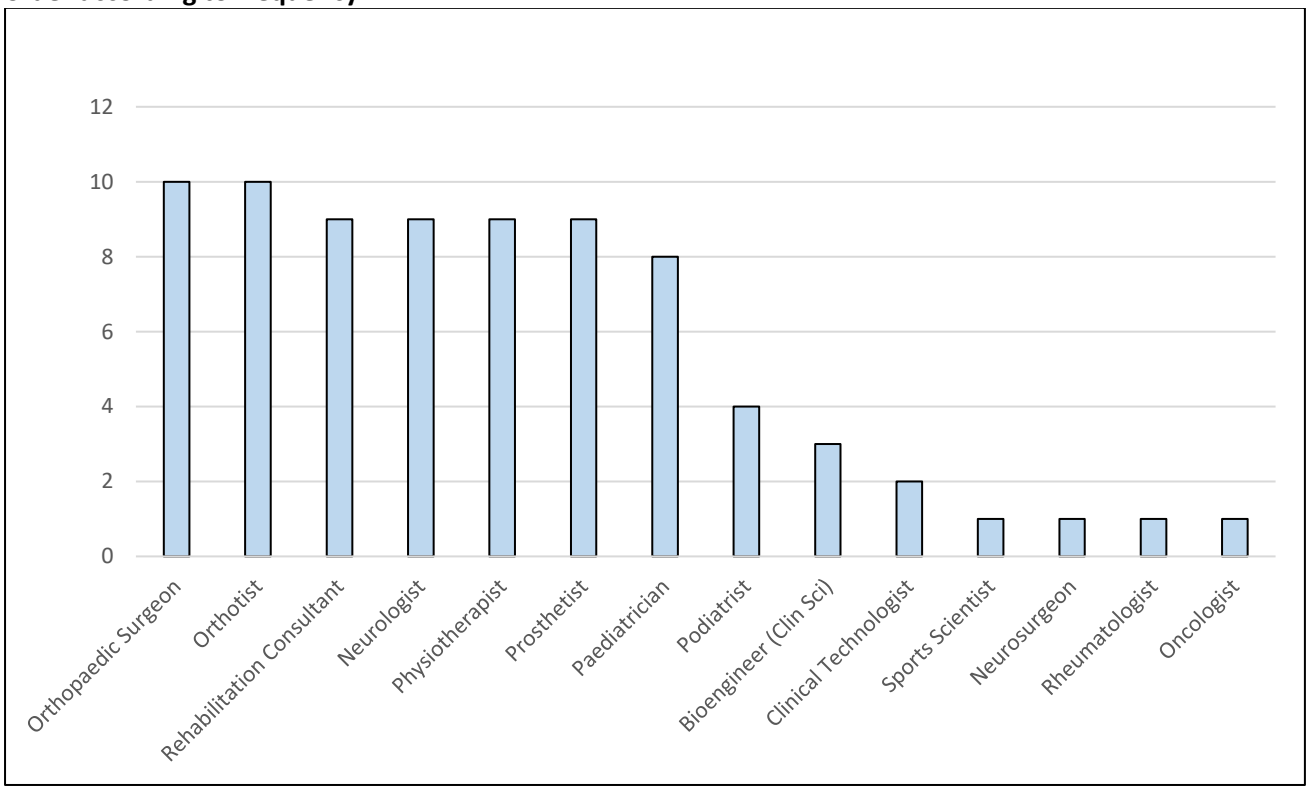
An overview of the profiles of professional disciplines available for consultation across CMAS accredited labs are presented in figures 5 and 6.

Figure 5. Profiles of professional disciplines available for consultation across CMAS accredited labs

	Orthopaedic Surgeon	Rehabilitation Consultant	Paediatrician	Neurologist	Physiotherapist	Sports Scientist	Bioengineer (Clin Sci)	Clinical Technologist	Orthotist	Prosthetist	Podiatrist	Other	
LAB ALPHA	X	X	X	X	X		X		X	X			
LAB BRAVO			X	X						X	X		
LAB CHARLIE	X			X	X				X	X			
LAB DELTA	X		X	X					X	X	X		
LAB ECHO	X								X				
LAB FOXTROT		X	X		X				X	X			
LAB GOLF		X	X	X	X								
LAB HOTEL		X	X	X									
LAB INDIA	X	X							X	X			
LAB JULIETT	X	X							X				
LAB KILO	X	X		X	X				X	X	X		
LAB LIMA			X	X	X		X				X	X	*
LAB MIKE	X	X		X	X		X	X	X	X			
LAB NOVEMBER	X	X	X		X			X	X	X		X	#
LAB OSCAR	X				X	X							

[#] Neurosurgeon; *Rheumatologist & Oncologist;

Figure 6. Professional roles available for consultation across CMAS accredited labs ranked in descending order according to frequency



5 Current practice for determining and recording competencies in CMAS accredited labs

5.1 System and profession-based approaches for competencies

Methods of demonstrating competencies was varied between CMAS accredited labs. In most cases (n=9) labs used a predominantly systems-based approach i.e. there was a protocol or series of competencies against which staff were mapped. Some labs (n=4) used a profession-based approach to competencies i.e. where competencies were associated with a single or limited number of professions. A mixed model of system and profession-based approach was used in some labs (n=2). Whilst a systems-based approach was used by the majority of labs, it was noted that in some cases, labs had a limited number or fewer professions employed that ultimately limited the option of multiple professions being able to undertake tasks requiring competency.

5.2 Steps/ stages to competency

5.2.1 Differences in practice

The number and type of competency levels varied both within and between labs. The number of competency categories between labs ranged from one to seven. The most common number of steps/stages of competency was between three to five, although the terminology varied considerably according to the lab, profession or task being assessed (table 1). The majority of labs (n=10) had a single framework of terminology for steps/stages to competency within the lab, whilst the remainder (n=5) had variable frameworks of terminology for steps/stages to competency, again dependant on profession or task being assessed. In a minority of labs (less than 5), different professions were also required to attend additional training courses e.g. *"have attended the ESMAC 3-day gait analysis course or similar)"* and have a minimum timescale of practice e.g. *"Minimum of 12 months working in the field of gait analysis"* or *"Attended >10 gait lab MDT reporting sessions".* Some labs were explicit in the number of patients or processes that had to be undertaken e.g. *"have practiced on at least 2 subjects"* for competency to be achieved, although this was not true for the majority of labs. Where labs (n=3) used a single category for recording competency had been achieved this usually required stipulation of the date on which the person was passed as competent.

Table 1. Example of steps/stages to competency across labs

LAB MIKE	Theory Discussed	Observed	Performed with Supervision	Performed Independently	Competent and Safe to work independently	Competent to teach	Repeatability Study Completed
LAB INDIA	Demo	Completed supervised	Completed independently				
LAB APLHA	With Assistance	Supervision	Independent				
LAB CHARLIE [+]	No experience	Acquainted with	Can perform under supervision	Can perform independently	Approved to mentor		
LAB NOVEMBER	Shadowed (at least 3 dates)	Work with supervision (at least 3 dates)	Lone working	Teaching			
LAB OSCAR	Theory	Peer Observation	Performed with supervision	Performed independently	Independently competent and safe	Competent to teach	
LAB HOTEL TASK A EXAMPLE *	Observed	Guided Patient	Collected data				
LAB HOTEL TASK B EXAMPLE *	Observed	Placed electrodes	Performed static	Checked static	Guided patient	Collected data	Processed data
LAB LIMA STAFF A EXAMPLE (PHYSIO) º	Start of Training	Start of Practical Experience	Independent				
LAB LIMA STAFF B EXAMPLE (CLINICAL SCIENTIST) º	Knowledge of Protocol	Performed with assistance/supervision	Independent performance				

[+] Aligned to ISO 13485 /BS70000; * Aligned to ISO 9001; ºundergone MPACE pilot

5.2.2 Similarities in practice

There is variability in both certifying competencies and, possibly, in the competencies themselves competency between labs, however, there were some examples of very similar or identical practice. Two clusters of similar practice were identified. Cluster one, comprised of Three labs (LABS DELTA, CHARLIE, JULIETT) used a similar framework for levels of competencies (Table 2) which were additionally supported by a predetermined criterion of what could be used as evidence (Table 3). No other labs were identified as having a predetermined criterion of what could be used as evidence[5].

Table 2. Cluster 1 demonstrating similar levels of competency used between three labs

LABS DELTA[+] & JULIETT	No experience (0)	Acquainted with (1)	Can perform under supervision (2)	Can perform independently (3)	Approved to mentor (4)
LAB CHARLIE	No experience	Acquainted	Can perform under supervision	Can perform independently	Approved to mentor

Table 3. Cluster 1 demonstrating similar criteria used to evidence competency

LAB DELTA	**LABS CHARLIE and JULIETT**
Direct Observed Practical Skills (DOPS)	Direct Observed Practical Skills (DOPS)
Observed Clinical Events (OCE);	Observed Clinical Events (OCE);
Case Study Discussion (CSD)	Case Study Discussion and Presentation (CSDP)
Note Audit (NA)	Clinical Notes Audit (CNA)
	Training Certificate (TC)
	Repeatability Studies (RS)
Lecture/in service presentation (P),	
CMAS audit work (CA).	

Cluster 2 comprised of two labs (LABS BETA and OSCAR) also a similar shared framework for levels of competencies (Table 4).

[5] One lab (DELTA) was also identified as having additional 'sources of evidence' / criteria used for evidencing for competency (approx. 120 unique phrases) which were similar to the all the criteria outlined in table 3.

Table 4. Cluster 2 demonstrating similar levels of competency used between three labs

LAB OSCAR	Theory	Peer Observation	Performed with supervision	Performed independently	Independently competent and safe	Competent to teach
LAB BETA	Theory/Discussed	Observed	Performed with supervision	Performed independently	Competent to teach	

5.2.3 Number of domains assessed for competency

All labs were CMAS accredited and therefore had a list of individual competences related to the domains of patient history taking, clinical examination, data collection, data interpretation, scope of clinical recommendations. There was considerable variation in the number of subdomains associated with each of the aforementioned domains, e.g. one lab (ALPHA) had eight domains/procedures/tasks against which staff were assessed for competency and another lab (DELTA) had more than 200.

6 Recommendations for a competency framework and supporting documents

6.1 Documentation and processes available for CMAS accreditation

Labs seeking CMAS accreditation will likely be provided with and required to undertake processes outlined in documentation relating to

1) Clinical Movement Analysis Society – UK and Ireland - Clinical Gait Analysis Standards – guide to accreditation Version 14: Valid April 2020 - April 2021
2) Clinical Movement Analysis Society - UK and Ireland - Clinical Movement Analysis Standards Document Version 14 approved by membership: 20 November 2020,
3) Clinical Movement Analysis Society - UK and Ireland Audit checklists Version 14.2: Jan 2021 – Jul 2021

and additionally

4) form a "Buddy" arrangement with an existing CMAS accredited lab.

On review of the documentation, criteria are explicit, however processes for accreditation may benefit from consolidation and enhanced clarity of the information both within and between documents Table 6. e.g. in the guide to CMAS accreditation document it stipulates

- Overview of the standards - there are seven key area's for accreditation and then a subsequent section identifies
- Minimum requirements -a set of minimum criteria which contains 14 domains and sub domains.

It is also recognised that in the Clinical Movement Analysis Standards Document individual competencies are required in five domains which ultimately inform the provision at a service level. It is recommended that a core set of competencies than spans both the service and individual levels is identified and consolidated between relevant documents.

Table 6. Overview of requirements regarding accreditation and competencies for CMAS

Clinical Gait Analysis Standards **2. Overview of the standards**	**Clinical Gait Analysis Standards** **3. Minimum requirements**	**Clinical Movement Analysis Standards Document** **1. Staffing - 4**

• Resources and facilities
• Referral management
• Data collection
• Data & report management
• Document control
• Audit
• Accreditation
	• A statement of purpose form
	  o Logs containing details of
	  o Staff members and internal auditors
	• Equipment
	• For each test performed:
	  o Data collection, data processing and reporting protocols
	  o Data collection and processing recording methods (i.e. forms)
	  o Staff repeatability records if the test requires clinical or technical judgement
	  o Normative data if appropriate
	• Patient records (providing evidence of completed recording methods and reports)
	  o In order for external audits to be completed in full, it is required that the lab have assessed at least 6 patients before the 1st external audit
	• Calibration or inspection records for key equipment
	• Internal and external audit records
	• A master list of all protocols and forms
		• Patient history taking
		• Clinical examination
		• Data collection
		• Data interpretation
		• Scope of clinical recommendations

6.2 Frameworks, steps/stages and evidencing competencies

As a result of the buddy lab system associated with the CMAS accreditation process, it is likely that labs will adopt similar practices to the labs that they have been partnered with. This may explain the similarities in practice identified within this report as most can be explained by geographical proximity. In order to facilitate greater consistency in practice a central document/ example of processes for running a clinical service and documenting competency (developed in partnership with CMAS members) could be developed. Whilst not covered in this report, examples/development of protocols, aligned to the areas of competency identified could be developed and shared with the ultimate aim of assisting new labs in getting their CMAS accreditation.

A systems-based approach is recommended for labs seeking accreditation i.e. a protocol or series of competencies against which staff can mapped with sufficient detail to identify the main skills required. This may also be used to inform educational initiatives within the CMAS membership and community. In order to facilitate this, a universal classification framework and number of competency levels could be developed. Included in this could be an explicit list of predetermined criterion and explicit number of times a task needs to be undertaken to evidence competencies could enhance consistent practice. It is considered this is done in some cases regarding repeatability with explicit thresholds regarding error or measurement.

On review of the CMAS standards document the process regarding competency suggests a process of shadowing[6], competence and then able to sign of competence for other members of staff. This suggests a competency framework comprised of three levels. Some existing competency frameworks identified from labs may therefore have redundancy or insufficient number of levels.

It is recognised that the staff profiles and number or activities or domains requiring evidence of competency likely reflect the clinical services provided by that lab, including available technology. This may additionally be influenced by the skill set of existing staff or professions who are employed by the lab. As a result, development

[6] It Is noted very few labs use the term shadowed, “observed” was a more common phrase

of a ‘one size fits all’ minimum universal number of domains for ensuring competency which is aligned to the CMAS standards would be challenging. However, development of reference template with similar competencies and examples of good practice, developed in collaboration with CMAS members could be developed. Accreditation would therefore also be subject to staff profiles i.e. levels of proficiency/competencies within the service rather than profession type.

7 Summary of recommendations

A summary of the main recommendations from this report have been provided below. It is recommended that:

- Existing documentation would undergo consolidation and enhanced clarity of the information contained within, specifically relating to requirements and processes surrounding competency
- A central document/ example of processes for running a clinical service and documenting tasks/ domains for competency is developed in partnership with CMAS members and labs.
    - This could be expanded to include protocols aligned to the domains for competency
- Systems-based approaches are adopted for labs seeking accreditation and these are supported by
    - a universal classification framework for levels of competency
    - number of competency levels
    - an explicit list of predetermined criterion
    - explicit number of times a tasks/thresholds to be undertaken to evidence competencies could enhance consistent practice.

8 Example of document/supplementary file available for new labs seeking CMAS accreditation.

The following section has been compiled by replicating the processes and wording used to determine competency from multiple labs. In some cases, wording/competencies have been modified or consolidated/merged from multiple labs. This section is intended to provide a broad overview and therefore contain repetitive or redundant information. The aim of structuring the information in this way is that it would serve as a template for discussion should CMAS look to develop an exemplary set of competencies for new labs seeking CMAS accreditation.

8.1 Service requirements

It is likely that a lab and associated staffing profile will be structured in response to the clinical service it hopes/ is required to provide. External affiliation bodies recommend a minimum of a 0.5 whole time equivalent Clinical Scientist for appropriate delivery of any instrumented clinical movement analysis service[7]. Services that do not have sufficient throughput to justify this time allocation are probably too small to implement and maintain appropriate levels of service provision[8].

CMAS standards recognise it is necessary to have

- a minimum of two staff employed to run a laboratory, one of whom must be a CMAS member and/or registered with a professional body
- a skill mix within the staff team, including clinical, technical and scientific expertise.
- This should include at least one member of staff with a clinical and one with a technical background.

It is anticipated that a full 3D gait/ movement analysis session will last between 1.5 hours to 2 hours maximum. The duration of sessions may vary dependant on the assessments being carried out e.g. a gait assessment with video or pedobarography is anticipated to last between 1 to 1.5 hours maximum.

[7] IPEM Clinical Scientists in Clinical Movement Analysis: Standards for Practice
[8] IPEM Clinical Scientists in Clinical Movement Analysis: Standards for Practice

It is recommended that the order of assessment is kept consistent e.g. for 3D movement analysis sessions

- Patient history taking (20 minutes)
- Confirmation of patient details (outcome form), consent, patient change, clinical examination(20-30mins)
- Video (5-10 mins)
- Other data (up to 20 mins depending on data)
- Brief discussion – keep to minimum until interpreted data).
- Account for delays.

8.2 Referral processes

CMAS required protocol

In order for appropriate service delivery individuals within the movement analysis individuals/labs should be competent to

- Undertake referral screening, and have clinical knowledge and understanding in order to make decisions on the appropriateness and urgency for movement analysis. Individual competency domains to include
    - Significance of diagnosis /prognosis with regard to movement assessment/gait
    - Appropriateness of referral
    - Need for prioritisation
    - Sufficiency of referral information and where can/need to obtain additional information from e.g. Referrer
- Produce the appropriate patient movement analysis/gait assessment/ design and specification details /making decisions on the types of data to be collected in order to answer the referral request. Individual competency domains to include
    - Understanding of patient referral letter and the movement/gait analysis question asked.

- Patient diagnosis, prognosis, associated movement disorders and the implications for movement/gait assessment and patient capacity to participate.
- Consideration of previous movement/gait data
- Effects of orthotics, prosthetics, walking aids on movement/gait and implications for movement/gait data acquisition.
- Data required for assessment of the effect of medical /surgical interventions (previous or proposed).
- Decisions on requirement/ suitability of the available movement/gait measurement technologies for specific referrals.

8.3 Patient History taking

Competencies to include:

- Access and review patient's previous gait reports and referral letter prior to their arrival.
- Prior to the assessment, selection and provision of appropriate Patient reported outcome measures (PROMS), pre-screening clinical and past medical history questionnaires alongside interpretation of responses
- Able to obtain informed patient consent for the collection, retention and potential use of their data. Is able to provide sensitive exchange of information, reassurance and responses to any queries and concerns raised
- Ability to adapt examination if required to meet patient's needs e.g.: behaviour / understanding and document on form
- It is anticipated that a patient history taking session should be completed within 20 to 30 minutes for most patients. Individuals should competent in complete a clinical history in sufficient depth to answer the referral question, and in a timely manner i.e. able to obtain an accurate, detailed and appropriate medical and social history from the patient and/ or carer, for example

- Patient reported presenting condition (PC)
- Functional/Walking ability and limitations e.g. falls history, reduced activity
    - Therapy management details and current/ongoing treatment plan
    - Orthosis/Assistive technology information
- Relevant past medical history (PMH)
    - Identification of relevant co-morbidities
    - Relevant previous / current treatments and outcomes, including Surgery, Botulinum toxin, Physiotherapy
- Drug history (e.g. baclofen, dantrolene, epilepsy medication) (DH)
- Social history
    - Support available
    - Goals/expectations/wishes of patient/carers/ family for movement analysis

- During the appointment is able to make decisions on modifications to the movement/gait analysis design specification plan in collaboration with colleagues, the patient and/or carer
- To make an assessment of the risks involved (risk assessment) and their mitigation and an understanding of the effects the changes will have on the movement/gait analysis findings.

8.4 Clinical examination

Individual competency domains to include:

- Demonstrates competent manual handling skills of patients with complex neuromuscular, orthopaedic and behavioural conditions and the movement/ lab equipment to ensure maximal patient participation and acquisition of accurate reliable gait data whilst maintaining compliance with national and local policies.
- Demonstrate appropriate levels of measurement repeatability during the annual repeatability tests.

- Use a consistent order of testing (within clinical limitations) to minimise change of position for patient and to facilitate efficient recording of outcomes (for patient and measurer) and to avoid omitting tests. Suggested order to be demonstrated
- Knowledge of functional/ superficial anatomy
- Surface anatomy and palpation
- Take photographs – and describe appropriately
- Able to communicate appropriately to ensure understanding, cooperation and participation of the patient /carer and colleague(s) enabling a safe and efficient completion of the movement/gait assessment
- Measurement of joint angles/ ranges
- Measurement of anthropometric parameters
- Assessment of spasticity
- Assessment of strength and selective control
- Anthropometric measurement
- Measuring
- Scribing

8.5 Data collection

8.5.1 Room preparation and calibration of equipment for data collection

Individual competency domains to include

- Ensure the gait lab environment is suitable for conducting a gait assessment (i.e. clean, safe and correct temperature)
- Is able to undertake equipment calibration and maintenance including both daily and 6-month activities and to have the knowledge to determine whether the equipment is operating within the set limits required to generate accurate data

- Ability to undertake all activities required by the gait labs' six-monthly testing and repeatability procedures and to be able to apply corrective measures e.g. changes to equipment, organising training etc if results are outside the set limits.
- 5.4 Is able to detect equipment malfunction and troubleshoot such problems, including liaising with the equipment manufacturer and local IT services.
- Demonstrate knowledge of the local protocol for daily equipment accuracy checks
    - Hardware set-up
    - Camera calibration
    - Force plate calibration
    - Software – create session and attach model
    - Troubleshooting

8.5.2 Processes for data collection

CMAS required protocol for data collection

Individual competency domains to include:

- 3D Acquisition – Can adequately capture high quality 3D data during a clinic, with good marker detection and foot strikes recorded. Demonstrates competence in completing the acquisition form in full
- Able to collect all relevant movement/gait data accurately, reliably and in a timely manner.
- Demonstrate accurate use of basic measurement devices, such as; goniometer, callipers, tape measures (hand-held and wall mounted) and weighing scales
- Selection of activity/task to be assessed e.g. gait, SHUE / AHA and required equipment
- Ensure that /movement/ walking pattern is representative of the patient's usual pattern (using distraction where required)
- Demonstrate an understanding of how much movement/walking data is sufficient.

- Motion analysis sessions
    - Patient set-up
    - Creating session
    - Protocol selection
    - Marker placement
        - To place markers on the required limb segments accurately and reliably to allow collection of high-quality data.
            - Ensure good level of knowledge of marker placement in relation to modelling for both lower limb and foot models to facilitate accurate marker placement.
            - Demonstrates an understanding of the importance of Marker Placement and its impact on the kinematics and kinetics, with an appreciation for how/when to use correct for non-standard placement i.e. obscured markers
    - EMG electrode placement
    - Video protocol
    - Patient/Model selection
    - Able identify any faults in data acquisition
- Problem solving e.g. During an assessment is able to identify, manage, and problem solve any equipment inaccuracies, errors, or malfunctioning and is able to propose alternative tests to provide similar data.
- Data Integrity – Knows what makes 2D and 3D data “good quality” and how to improve capture to increase data quality. Understands when to disregard data due technical artefacts/non-typical gaits and how much data must be collected as a minimum. Make appropriate decisions regarding which trials to include in the analysis

8.6 Data interpretation

8.6.1 Processing and quality assurance checks

- Demonstrates the ability to identify technical artefacts and their likely cause, key differences in graph data, when to disregard trials, and whether the graphs are suitable for reporting. Make appropriate decisions regarding which trials to include in the analysis
    - Including images from video data/ photos
    - Extract relevant still digital images from the sagittal and coronal DV cameras as required.
- 2D
    - Processing 2D Data – Can correctly export the video vector ready for reporting, highlighting only clean strikes and removing any irregular vectors prior to compilation.
- 3D
    - Manually label any 3D marker trajectories
        - Post processing gap filling
        - Event labelling + reliability
        - Movement/ Gait Phases + reliability
        - filtering
        - Selection and application of correct model
        - eventing trials (static and dynamic)
        - filtering EMG where required
        - Spatiotemporal parameters
    - Able identify any faults in data acquisition
    - Ability to detect of accuracy of all data collected, data artefacts, to understand and explain the reasons for the artefacts (including marker placement errors, equipment malfunctions, issues relating to the /movement gait analysis modelling) and to be able to apply corrections where appropriate.
        - Post processing KAD + TRO adjustment

- Be aware of quality control issues with data (varus/valgus wave / extreme values / pelvic tilt / obliquity
- Post processing MAP&GPS
- Post processing creating polygon reports (varcons +std + prepost)
- Polygon modifications

8.6.2 Clinical interpretation

- Demonstrates ability to interpret graph data and identify deviations from normative values
- Demonstrate an understanding of what effect any measured impairments might have on the patient's movement/ gait pattern.
- Ability to accurately and concisely create and contribute to movement/ gait report using the movement/ gait report template
- Demonstrate an ability to comment on the significant findings at an MDT meeting.
- Clinical Engineer (other) to be able to explain any technical limitations or artefacts.
- Be aware of limitations of model.
- Be able to interpret kinematic/kinetic data in relation to referral question and be aware of limitations of data collection and model.

8.6.3 Reporting (Pre-scope of clinical recommendations)

- Importing information for production of movement analysis/ gait graphs/ report in recognised format N.B. There is an established convention for the lower limb but not so for the upper limb
- 2D Reporting
    - Can correctly edit and compile the 2D video vector video for reporting, following the correct reporting order.
- 3D Reporting

    - Is able to compile the 3D report ready for review, making notes of any irregular trials and highlighting key limitations/abnormalities in the kinematic and kinetic graphs.
- Ability to use knowledge of the movement/ gait analysis model and hardware limitations to report on the accuracy of collected data
- Demonstrate an understanding of what effect any measured impairments might have on the patient's movement/gait pattern.
- Identify any abnormalities or impairments relative to normal data values.
- Demonstrate an ability to comment on the significant finding's clinical examination at an MDT meeting
    - Comments on consistency / quality
    - GPS and MAP graphs
    - Explanation of biomechanical /gait model - calculation of angles
    - How inter- and intra-variability affect results
    - Local protocol for marker placement and understand its limitations
    - Identification and application of appropriate processing techniques to biomechanical assessment data according to protocol i.e. removing artefacts
- Process normal data and compare to normal database
- Report Production/Interpretation
    - Patient History
    - Physical exam marking
    - Video Description
    - Graph marking
    - Impairments Identification
    - Graph Interpretation
    - Process of reporting
- Problem solving

CMAS required protocol

8.7 Scope of Clinical recommendations

- Be able to produce a high-quality movement/gait report with clear evidence of data interpretation and justification for treatment recommendations.
    - Report needs to be detailed but concise, and to include exam and data collected.
    - Suggested length 3 pages for written information.
    - Aim to write report within week of seeing patient (to keep on top of caseload) and be ready to discuss at next interpretation.
    - May additionally use clinical outcome measures of movement/ gait e.g. Edinburgh Gait Score
- Is able to clearly and meaningfully present /communicate and discus the movement/gait findings of their patient with different audiences, (clinical/professional settings) taking into account the situation/circumstances and levels of understanding of those involved. To accurately document discussions and multidisciplinary recommendations in patient notes and report
- Clinical reasoning process to answer the referral question and to:
    - Distinguish between primary and secondary movement/gait deviations to highlight the primary and possible secondary impairments.
    - Evidence coping strategies /mechanisms that enable the patient to walk as efficiently as possible utilising their own limited capabilities.
    - Rate severity of a movement/gait feature - Major/minor problems
    - Explain /provide insight into problems reported by the patient and referring clinician
    - Assess effectiveness of any treatment interventions
    - Aid decisions re: prognosis/ production of a diagnosis / potential interventions to improve or prevent deterioration of movement/gait.
    - Distinguish between impairments that can be treated and ones that can not.

    - Identify environmental and social factors that influence individuals / family's capacity to cope with proposed interventions.
    - Recommendation s for patient movement/gait improvement and scope of practice.
- Ways to present clinical reasoning in movement/gait report summary e.g.
    - Movement/Gait deviation focused (explained in planes and levels of motion)
    - Impairment focused
    - Mixed
- Clinical reasoning and levels of confidence. The effect on clinical judgements and recommendations.
- Professional roles in discussions and production of MDT recommendations e.g. scope of practice, working experience/level of expertise, types of interventions.
- Presenting movement/gait cases to MDT
- Participate in MDT discussion (e.g. at least attend 10) on recommendations and show an enhanced understanding of the roles of the MDT or referral services associated with the labs e.g.
    - Treatment, Surgical, Therapy and Orthotic recommendations. For each respective recommendation the competencies are evidenced by
        - Qualified at the level of Consultant Orthopaedic Surgeon, and have suitable experience with movement/gait analysis
        - Qualified and HCPC registered orthotist, with experience of movement/gait analysis
        - Qualified and HCPC registered physiotherapist, with experience of movement/gait analysis
- Discussions with patients/carers and the scope of practice

CMAS required protocol

8.8 Data management and quality assurance

This is not covered as a requirement of the individual competencies within the CMAS documents but was recognised as a recurring theme throughout the competency documents. The main area's have been summarised below with some examples

1. Appropriate storage and backing up of clinical movement analysis data. It anticipated that this will be regulated by local trust policies and GDPR legislation[9] e.g.

- Transferring of data onto trust networks
    - Transfer raw video data files (*.vvid) from lab PC to correct network location (*.avi)

2. Updating and version control of service documents and protocols e.g.

- Knowledge of document management including version control, reviews, change requests and responsibilities of document ownership.
- Ability to operate quality management software (e.g. Q-pulse) to be able to review documents, request changes to documents.

3. Processes surrounding audits for trust specific requirements and CMAS accreditation e.g.

- Working knowledge of the CMAS standards and checklists and the ability to prepare for internal and external audits.
- Knowledge of the local quality management system, including its structure and all movement/gait lab processes, procedures, standard operating protocols, forms, and information documents.
- **Audit processes**
    - Knowledge of movement/gait lab protocols and procedures
    - Knowledge of CMAS standards

[9] https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/

- Knowledge local standards
- Participated in own internal audit
- Participated in own external audit
- Performed an external audit (shadowed)
- Performed an external audit (independently)

9 Knowledge frameworks for developing competency

It is recognised that in order to achieve the competencies outlined above, practice will need to be underpinned by a core knowledge set. The core principles have been outlined below which may inform future training and educational initiatives by CMAS.

9.1 Anatomy

- Has appropriate knowledge, understanding and skills in surface and functional anatomy and the effects of any pathology on these. Is able to apply this to accurately undertake the movement/gait lab procedures of physical examination, marker, sensor and electrode placement and in assessing the suitability /fit of e.g. orthotics, prosthetics and any aids.

9.2 Technical knowledge

- Has working knowledge, understanding and skills to competently operate all the clinical movement/gait analysis equipment and software available, demonstrating an understanding of their function and use and ensuring that the data collected is as accurate and reliable as possible.

9.3 Assistive technology, orthotics/ prosthetics

- Has working knowledge, understanding and skills in orthotics, prosthetics and specialist footwear. Is able to discuss the function, designs, modifications and fitting of each, their biomechanical effects on movement/ gait and the appropriateness of a device for the patient. Shows awareness and understanding of poor fit /design and the potential detrimental effects on the patient and their movement/gait. Example provided below
    - Prosthetics
        - Foot /ankle types
        - Lower leg component types
        - Trans tibial and through knee sockets, suspension, liners

        - Trans femoral sockets, suspension, liners
        - Knee component types
        - Hip disarticulation and hemipelvectomy sockets, suspension, liners
        - Hip component types
    - Specialist Footwear
        - Shoe/boot styles
        - Shoe pitch,
        - Sole profiles
        - Shoe raise types
        - Heel /shoe wedge types
        - Shoe stiffening

- Has working knowledge of the various types and design of walking aids, their function, operation mechanisms, correct use and effect on the movement/gait data collected. Able to make decisions on their suitability of use during movement/gait assessments and the alternative options available.

9.4 Understanding human movement

- Has knowledge and understanding of movement analysis, the normal movement/gait cycle and the biomechanics and terminology used. Demonstrates an understanding of the purpose, function and control mechanisms involved for efficient movement/gait and the changes that occur in movement/gait data due to normal maturation and ageing as well as the effects of e.g. change in walking speed.
- Demonstrates expert working knowledge and understanding of the effect of impairments, ageing, disease progression, treatment interventions etc on movement patterns.
- Knowledge of conditions and their progression and the effect on gait/ movement task
- Show an awareness of the key references quoted in the biomechanical model document(s)

9.5 Measurement theory

- Demonstrates knowledge and understanding of the theory and rational for measurement and its application in instrumented clinical movement/gait analysis. Understands the types and purpose of the measurements available, the potential sources of error, the need for accuracy and for obtaining relevant normal data sets for comparison.
    - Types of measurement: descriptive, diagnostic, predictive
    - Objective vs subjective measurements
    - Direct vs indirect measurements
    - Accuracy and repeatability
    - Normal data
    - Purpose of measurements: quality, monitoring, problem solving, making something to fit (design etc)
    - Physical properties- Measurement: mass, length, time, volts, speed, forces, volume, acceleration/deceleration, displacement. (physical quantity)
    - Errors minor vs major
    - Measurement instruments and purpose
    - Calibration of equipment – purpose
    - Biomechanical principles involved in gait/movement analysis
    - Forces- linear /rotational/ internal and external and how they are generated. Action & reaction.
    - Understand differences between internal and external moments
    - Understand ground reaction forces
    - Construction of 3D body segments, relative motion, Angular motion, 3 Planes of motion and 6 degrees of freedom.
    - Mass, inertia and momentum
    - Speed /Acceleration/deceleration

- Centre of mass/ centre of Pressure
- Light and reflection, size and distance
- Shutter speeds
- Orientation of the lab in 3 dimensions
- Generation vs absorption of power.
- Integration of mixed data sources, methods and delays
- Electrical current and detection
- Medical devices regulations and use of in-house spreadsheets /programmes and validity of data.

- Understand how movement/gait analysis measurement equipment works (including motion capture system, force plates, EMG, pedobarograph) and the underlying principles of the different technologies. Here an example of a series of equipment within a CMAS lab set up is used
- Motion capture system types and Vicon equipment:
    - Vicon cameras , Reflective markers +KAD
    - video vector cameras
    - Calibration equipment
    - Nexus and polygon software
    - Data presentation
    - Proc 105 normal data
    - Force plate types + Ampti force plate system
    - Weights
    - Calibration pole
    - Integraton with Vicon equipment
    - Baseline settings
- EMG equiptment types + Delsys system
    - Software + hardware

    - Integration with Vicon equipment
- Activity monitoring equipment + ActivPAL system
    - Software + hardware
    - Data types and presentation
- Pressure measurement types + Tekscan Pedobarograph
    - Software + hardware
    - Data types
    - Normal data set production
    - Integration of video data
- Video camera types
- Canon
- Muscle stimulation
- General measurement tools: Goniometers, callipers etc

On the basis of this information, CMAS could produce educational resources/ courses for professionals looking to upskill in individuals in the relevant domains mentioned here. This document, in collaboration and consultation with CMAS members may also be used to provide examples of the processes required for CMAS accreditation. This information would need to be combined with the recommendations made in sections 6 and 7 of this report.