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Research Report

Compliance to DMD Care Considerations in the Netherlands

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Abstract.

Background and objective: To optimize care for patients with DMD, it is essential to know to what extent current care complies with the recommended monitoring frequencies suggested by the DMD care considerations. The objective of this study was to investigate the current care for patients with DMD in the Netherlands and to what extent the care complies with the international care considerations.

Methods: A cross-sectional questionnaire was carried out among the Dutch DMD patients and caregivers about the patients' functional and health status, visits to healthcare professionals, clinical tests and assessments, therapy, medication use and access to medical aids and devices. Compliance to guidelines was defined by comparing the frequency of visits to health care providers and clinical tests with the recommended frequencies derived from the care considerations of 2010.

Results: Eighty-four participants completed the questionnaire. The majority of participants met the recommended visit frequencies to a neuromuscular specialist and cardiologist. Compliance was suboptimal for respiratory assessments in the non-ambulatory phase, monitoring of side effects of corticosteroid use and neuromuscular assessments. Disease specific information supply was perceived as sufficient and participants were satisfied with the received care.

Conclusions: This study identifies areas in which compliance is lacking. Countries, such as the Netherlands, working according to a shared care system require easy and low-threshold communication between health care centers and a clear division of roles and responsibilities to reach optimal compliance. In the Netherlands the Duchenne Center Netherlands has the coordinating role.

Keywords: Duchenne muscular dystrophy, guideline, compliance, shared care

INTRODUCTION

Duchenne muscular dystrophy (DMD) is an X-linked recessive neuromuscular disorder with an estimated incidence of 1 in 4000–6000 live male births [1]. Affected individuals suffer progressive muscle degeneration that is caused by a mutation in the dystrophin gene. Symptoms usually present

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themselves from an early age with a mean age of diagnosis of approximately 5 years. Untreated, patients become non-ambulant before their teens and the life expectancy is 19 years [2]. Although there is no cure available, comprehensive multidisciplinary care has changed the natural history of the disease. Nowadays, the mean age patients become non-ambulant is in their early teens and the life expectancy has increased to the third or fourth decade of life due to corticosteroid therapy and cardiac, respiratory, orthopedic and rehabilitation interventions [2–5].

For a rare disease as DMD, experience and disease-specific clinical knowledge is imperative for best-practice treatment, which is challenging when care is provided in different settings. Shortcomings in knowledge and in recognition of the multisystem primary manifestations and secondary complications can lead to late advice and undertreatment. Suboptimal care can lead to a lower health status, which can lead to lower levels of participation and quality of life [6]. In an effort to improve care for DMD patients worldwide, the first international comprehensive care considerations for DMD were published in 2010 [7, 8]. They comprised recommendations of the total scope of clinical care issues affecting patients with DMD. The care considerations recommend timely screening of the patients' health to detect and anticipate on health issues. They offered recommended frequencies of visits to professionals, clinical tests and assessments, and timing and management of pharmacologic, assistive or therapeutic interventions. In 2018, a revised version of the care considerations appeared [9–11]. The original care considerations were updated and new topics were added. Not fully executing the recommendations introduces the risk of preventable medical complications and emergency hospital admittance. Also, differences in care between patients can cause differences in the natural history of the disease.

Although the care considerations are freely accessible for both professionals and patients, literature shows that compliance is not optimal. Landfeldt et al. (2015) showed that less than 27% of patients in Italy, Germany, the UK and the US met all absolute care recommendations which they defined as visit frequencies for neuromuscular, cardiac and respiratory management, physiotherapy sessions, and access to medical devices [12]. Vry et al. 2016 investigated neuromuscular, medical and psychosocial care in seven European countries. Results showed that almost a quarter of patients did not receive regular physiotherapy, echocardiograms were not performed in 22% of the patients and pulmonary functions were not regularly assessed in 71% of non-ambulatory patients [13]. Andrews et al. assessed compliance to the care considerations in the USA and identified several areas in which implementation was lacking. The recommendation for a twice a year neuromuscular visit was not met in 36% of patients and functional timed testing occurred in < 50% of patients. They also found suboptimal adherence to clinical monitoring of side effects of long-term corticosteroid use and scoliosis and adherence decreased with age and severity [14]. Rodger et al. demonstrated that *non*-attendance rates at a specialized clinic ranged from 11.9% in Denmark to 85.7% in Bulgaria [15]. Besides suboptimal adherence to the care considerations, significant differences in compliance between countries were reported [12, 13, 15]. The observed heterogeneity in compliance between countries may be explained by differences in care organization, access to care in general and the availability of specialized neuromuscular clinics. For example, there are specialized clinics, for example some in USA, which aim to provide all care aspect for DMD [16]. There are also specialized clinics that do not offer all necessary expertise and health care is seldom provided exclusively at a single center. In the Netherlands, care for DMD is organized according to the shared care principle, where multiple health care professionals from different health care centers together aim to provide multidisciplinary, coordinated and patient-centric care in accordance with the care considerations. Academic medical centers offer multidisciplinary follow up visits and work closely together with peripheral hospitals, rehabilitation centers, centers for home ventilation and first- and second-line care centers. Standardized assessment and diagnostics mainly take place in academic medical centers during the follow up visits while treatment and sometimes also assessments takes place in rehabilitation centers or in first- or second-line care centers.

To optimize care for patients with DMD, it is essential to know to what extent current care complies with the recommended specialist visits and clinical monitoring frequencies suggested by the care considerations. In the Netherlands, where care is organized according to the shared care principle, it is unknown to what extent the care considerations are implemented in clinical practice. The objective of this study was to investigate the current care of patients with DMD in the Netherlands and to what extent the care complies with the international care considerations.

METHODS

Design

This study was a cross-sectional survey study among patients with DMD and their caregivers in the Netherlands. The questionnaire consisted of questions about the patients' functional and health status, visits to healthcare professionals, clinical tests and assessments, therapy, medication use and access to medical aids and devices. Before distribution, the questionnaire was reviewed by patients and parents to ensure accuracy, completeness and understandability. The preparation of this study was started before the publication of the revised guidelines in 2018. We decided still to base the questionnaire on the 2010 version, as implementation takes time and we expected that the results could support an improved implementation process for the 2018 guidelines. The distribution of the questionnaire was in 2019–2020.

Participants

We approached patients with DMD who were registered in the Dutch Dystrophinopathy Database (DDD) and gave permission for being approached for research purposes ($n = 344$) [17]. Additionally, we approached patients treated at the Radboud University Medical Center which were not registered in the DDD ($n = 50$). Patients and parents were also informed by patient organizations. Exclusion criteria were female patients and patients who were ambulant while being over 16 years of age.

Procedure

Eligible patients were invited to complete an online or paper version of the questionnaire. All participants provided informed consent. Parents or other caregivers were allowed to assist in completing the questionnaire. For example in the case of young patients or questions about the childhood which the patient himself may not know the answer to or is not able to recall. Data were anonymized and handled according to the guidelines of good clinical practice. This study was approved by the medical ethical committee of the Leiden University Medical Center (no. NL 65159.058.18).

Outcome measures

The patients' functional status was assessed by the Brooke (a 6-point scale measuring upper extremity function) and Vignos scale (a 10-point scale measuring lower extremity function) [18, 19]. Disease stages were defined according to the care considerations [7]. Ambulant boys were in the early ambulatory (Vignos 1–3) or the late ambulatory stage (Vignos 4–8). Wheelchair-dependent boys/men were either in the early non-ambulatory stage with relative good arm function (Vignos 9-10, Brooke 1–3) or in the late non-ambulatory stage with limited arm function (Vignos 9-10, Brook > 4). Other indicators for health status were use of respiratory assistance, tube feeding, need for antibiotics, admissions to the hospital and presence or history of fractures and scoliosis.

The actual care was assessed by determining the frequency of visits to healthcare professionals and clinical tests and assessments. The results were stratified by the topics addressed in the initial care considerations of 2010, as the renewed version was not yet actively implemented in the Netherlands during data. For each topic, the recommended frequency was derived from the care considerations (also see the caption of Table 3). For diagnosis, outcome measures were a visit to a clinical geneticist and assessment of the diagnosis method. Neuromuscular and rehabilitation management consisted of twice a year visits to a neuromuscular specialist (a (pediatric) neurologist or (pediatric) rehabilitation physician), physiotherapist and occupational therapist, as well as twice a year assessments of muscle strength, range of motion and functional tests. Outcome measures for corticosteroid management and its side effects were twice a year screening for overweight, growth retardation, hypertension and annual screening for glucose intolerance, cataracts and bone demineralization. For psychosocial management, visits to a psychiatrist, psychologist and remedial educationalist and general psychological and neuropsychological examinations were assessed. For this topic, we could not calculate recommended frequencies as it is only indicated at the time around diagnosis, before entering school and after a change in function in the 2010 guideline, and our data only contained visits in the past year. Orthopedic management consisted of an annual visit to an orthopedic surgeon and spinal radiography. Respiratory management consists of annual respiratory clinical assessments for ambulatory patients and twice a year for non-ambulant patients. Outcome measures for cardiac management were a baseline (<10 years) or twice a year (>10 years) visit to a cardiologist and an ECG and ECHO (once per 2 years for ambulatory patients and annual for non-ambulatory patients according to the guideline of 2010). Besides recommended frequencies, we also reported the percentage of patients with any kind of visit the past year. For each topic, the patients were stratified according to either functional status or age, depending on what was described for each particular recommendation in the care considerations. Additional information was collected by questions about travel time to the medical center, frequency and duration of therapy, access to and need for medical devices, medication use and information received from health care professionals. Lastly, satisfaction with care was assessed by a 5 point Likert scale and an open question was added where participants could elaborate about their (dis)satisfaction with their care.

Statistical analysis

Descriptive statistics were used to summarize patient characteristics. Means, medians, and confidence intervals (95%) were reported for the annual rate of visits to professionals and clinical test and assessments. Compliance to the recommendations was determined by comparing the annual visit rate to the recommended frequency of the visit and reported as a percentage. The statistical analyses were carried out using SPSS version 25.0 (IBM SPSS, Inc., Armonk, New York).

RESULTS

Participants characteristics

Table 1 shows the participants characteristics. Of the 394 patients who were approached, 84 completed the questionnaire (overall response rate 21.3%). Of the remaining patients, 229 did not respond, 34 declined, 16 appeared to be deceased, and 28 created an account, but did not complete the questionnaire. Three patients were excluded because of the age of loss of ambulation exceeding 16 years. Of the participants 83.3% was in the non-ambulatory stage ($n = 67$) with a mean age of loss of ambulation at 10.7 years (SD = 2.3), while 16.2% of the participants was in the ambulatory stage ($n = 13$). Two participants were categorized in the 'late ambulant stage' according to the Vignos scale, however considered themselves as non-ambulant.

Follow up and specialist visits

In our study population, 82.1% ($n = 69$) reported having a multidisciplinary once or twice a year follow up visit in a specialized center. For 82.1% of the participants there was a care-coordinator or nurse available to ask care related questions and 92.5% received a summary report of the visit. Table 2 shows the percentage of participants that had a minimum of 1 visit for a particular specialist in the past year. Other visits (not included in the table) were referral to a dietician (mentioned twice) and a visit to a dermatologist, hand therapist, orthodontist, movement therapist in the swimming pool, cardiac nurse and an ear nose and throat specialist (mentioned once). The travel time to the center in which the follow up visit takes place was less than 1 hour for 53.6% of the participants and 1 to 3 hours for 46.4% of the participants. The vast majority (92.8%) reported to have no problem with the travel time.

Diagnosis

The mean age of diagnosis was 4.7 years (SD = 2.6). For the majority of participants (70.7%), their parents had a visit with a clinical geneticist around the time of diagnosis. As diagnosis method, 64.3% of the participants reported to have had a muscle biopsy, 65.5% had blood withdrawal for genetic testing and 69.0% had a creatinine kinase measurement (multiple answers were allowed). In 9.5% of the participants, DMD occurred in the family history. In 54.2% of participants, their parents received information about the diagnosis, 77.6% about heredity, 85.7% about female carriers and 33.3% about having children.

Neuromuscular and rehabilitation management

The majority of the participants met the recommended frequency of twice a year visit to a neuromuscular specialist (either a (pediatric) neurologist or (pediatric) rehabilitation physician) (86.9%), a physiotherapy visit (88.1%) and an occupational visit (61.9%). Also, the majority of participants had an annual range of motion assessment of the lower and upper extremity (both 68.3%), but fewer met the recommended visit frequency of twice a year (32.9% and 31.7% respectively). In the ambulatory stage, over half of the participants met the recommended visit frequency for functional test of the lower extremity (53.8%). For functional tests recommended frequencies of the upper extremity were met in 53.8% of ambulatory participants and in 32.3% of non-ambulatory participants. Overall, participants in the ambulatory stage were more compliant to the care considerations than participants in

Table 1
Patient characteristics

	N	%	Mean age (SD)	Median age (Q1–Q3)	Min	Max
Total group	84	100.0	22.0 (10.0)	21.5 (14–29)	5	50
< 10 years	7	8.3	7.9 (1.6)	9.0 (7–9)	5	9
≥ 10 years	77	91.7	23.3 (9.4)	23.0 (15.5–30)	10	50
Age per disease stage	80					
Early ambulatory	10	12.5	10.2 (2.3)	10.0 (7–13.3)	5	15
Late ambulatory	3	3.7	12.7 (6.4)	9.0 (9–14.5)	9	20
Early non-ambulatory	18	22.5	15.8 (4.5)	15.0 (13–18.3)	10	25
Late non-ambulatory	49	61.3	27.3 (8.9)	27.0 (21–32)	9	50
Age loss of ambulation	60	71.4	10.7 (2.0)	11.0 (9.3–12)	6	15
Living situation	84					
Home with parents	67	80.5	19.3 (8.2)	8.0 (13–25)	5	41
Institution/guided	8	9.1	28.6 (9.2)	25.0 (21.5–36)	18	45
Independent	9	10.3	37.6 (6.7)	37.5 (31–42)	30	50
Corticosteroid status	82					
Using corticosteroids	43	52.4	15.8 (6.2)	15.0 (10–22)	5	28
Daily	1	2.4	NA	NA	NA	NA
Intermittent	40	97.6	15.8 (6.3)	14.5 (10–22.3)	5	28
Not using corticosteoids	27	32.9	32.4 (7.9)	31.0 (28–39)	15	15
Corticosteroid stopped	12	14.6	21.3 (5.2)	20.5 (17.3–26)	13	30
Ventilation	78					
No ventilation	39	49.4	15.3 (16.0)	14.0 (10–20)	5	30
Non invasive ventilation	29	36.7	26.8 (6.9)	27.0 (21.5–31)	16	39
Invasive ventilation	10	12.7	35.9 (9.4)	37.0 (27.8–43.5)	10	50
Tube feeding	79					
No	64	81.0	20.5 (10.0)	19.0 (13–25.6)	5	50
Nasogasrtic tube	1	1.3	NA	NA	NA	NA
PEG/PRG tube	14	17.7	28.9 (8.0)	28.5 (22.5–35.3)	16	41
Fracture history	79					
Yes	37	46.8	25.6 (9.4)	25.0 (17.5–32)	11	50
No	42	53.2	19.0 (9.8)	16.5 (10–25)	5	45
Scoliosis	75					
Yes	45	60.0	25.0 (9.2)	24.0 (17–30)	10	50
No	30	40.0	16.7 (9.1)	14.0 (9.8–24)	5	40
Age scoliosis operation	30	NA	15.3 (1.9)	15.0 (14–16)	13	22
Annual flu shot	83					
Yes	76	91.6	22.4 (10.2)	22.0 (14–30)	5	50
No	7	8.4	17.7 (6.5)	15.0 (13–23)	10	29
Vaccinations	81					
Yes	78	96.3	21.3 (9.6)	20.5 (13.8–28.3)	5	45
No	3	3.7	33.0 (15.7)	30.0 (NA)	19	50
Antibiotic treatment	80					
Yes	21	26.3	28.4 (9.2)	28.0 (11) 23.5–34	11	45
No	59	73.8	9.7 (9.4)	18.0 (12) 16–25	5	50
Hospitalization	80					
Yes	18	22.5	25.4 (9.4)	26.5 (14) 16.8–31	10	41
No	62	77.5	21.0 (10.1)	19.5 (14) 13–27.3	5	50

the non-ambulatory stage. Table 3.1 shows the proportion of participants meeting the visit frequency for neuromuscular and rehabilitation management recommended in the care considerations.

Of the participants 36.7% reported to take part in adapted sports such as wheelchair hockey, 35.4% participated in adapted sports in the past, while 27.8% never participated. The majority of participants received information about exercise (77.8%), being under- or overweight (83.3%), a healthy diet (76.2%) and the disease course (82.7%) from their health care professional while a smaller percentage (19.3%, 12.0%, 21.0% and 16.0% respectively) did not receive information about these topics or found the information insufficient. Of the participants 80.7% was questioned annually by their healthcare professional about activities in daily life, 90.4% about difficulties with swallowing, 28.0% about reflux, 80.7% about obstipation and 79.0% about difficulties with micturition.

Participants reported to have access to medical equipment or aids they needed. These included

Table 2
The percentage of patients with ≥ 1 visit in the past year to the specialist

Speciaist	*n*	≥ 1 visit %
Dentist	82	96.3
Neuromuscular specialist*	84	95.2
Cardiologist	84	95.2
Physiotherapist	73	93.2
General practitioner	78	83.3
Occupational therapist	76	80.3
Pulmonologist	81	75.3
Home ventilation center specialist	84	75.0
Nurse	76	55.3
Orthopedist	78	43.6
Speech and language therapist	75	42.7
Pediatrician	79	40.5
Pain specialist	79	38.0
Psychologist	79	21.5
Urologist	79	16.5
Ophthalmologist	78	15.4
Remedial educationalist	79	11.4
Psychiatrist	79	6.3
Endocrinologist	78	5.1

Legend: *A neuromuscular specialist is defined as either a neurologist or a rehabilitation physician.

(electric) wheelchairs, a hoist, bathroom aids, adapted bed and mattress, standing table, eating aids, speech assistance, splints, orthopedic shoes, dynamic arm support and a robot arm. A dynamic arm support was used by 33.8% of participants and 15.8% used a robot arm. For the dynamic arm support and the robot arm there were some particpants who reported to need the device but do not have access to it (7.5% and 13.2% respectively). Although access to medical equipment seems adequate, participants mentioned they experienced problems with application procedures of aids. It takes a lot of time and the procedures are comprehensive. Also, several participants mentioned discomfort in using night splints. Still, 63.3% was satisfied about their night splints, while 23.4% was dissatisfied.

The participants reported in 89% to have a weekly physiotherapy session, of which the duration of the session is ≥ 60 minutes for 49.0% of these patients. In 9.9% they had a weekly speech and language therapy session, 26.8% had a weekly occupational therapy session, 23.2% had a weekly hydrotherapy session.

Corticosteroid management

Over half of the participants used corticosteroids (52.4%) of which the majority on an intermittent schedule (97.6%). Table 3.2 shows the proportion of all participants meeting the monitoring frequencies for corticosteroid therapy side effects recommended in the care considerations, as measuring weight/height/blood pressure/bone quality is not only of importance for participants that use corticosteroids, we reported it for all participants. The results showed that the monitoring of height, weight and blood pressure is done annually for the majority of participants, but fewer met the recommended frequency (which is twice per year). Looking at the participants that used corticosteroid at the time of the questionnaire the following results were found: height in 91,2% once per year of which 44,1% twice a year; weight 97,2% once per year of which 61,1% twice per year; blood pressure was measured in 100% once per year of which 68,8% twice per year; DEXA scan was made yearly in 51,2% and x-ray in 72.5%; ophthalmology was only done in 16.3% in the last year. The type of steroids which were used were prednisone (83.7%) and deflazacort (16.3%). Reasons for stopping corticosteroid therapy were loss of ambulation (23.1%) and side effects (84.6%). One third of the participants (32.9%) had never used steroids (of which 1 participant was ambulant and 25 participants were non-ambulant). Information received about corticosteroid therapy and side effects was sufficient for 61.3% of the participants, 32.5% found the information insufficient or never received this information.

Most participants used calcium and vitamin D supplements (63.7% and 72.3%, resp). Reasons for not using or stopping the supplements were side effects or having a sufficient calcium and vitamin D intake through the diet.

Psychosocial management

Referral to a mental health care professional is recommended in case of a positive screening on mental health problems. Table 3.3 shows the proportion of participants with a visit to mental health care professionals.

The majority of participants found the information they received about education and learning difficulties, psychological assistance with behavior and emotional coping and the existence of patient organizations sufficient (65.4%, 64.2% and 84.0% respectively). A smaller percentage of participants found the information about these aforementioned topics insufficient or did not receive information about these topics (30.9%, 28.4% and 11.1% respectively).

Orthopedic management

In the past year, 40.5% of the participants had a visit to an orthopedic surgeon. A spinal radiograph was

Table 3

Compliance to the 2010 care considerations and annual visit rates

Visit outcome measure			Care considerations		Annual visit rate[4]			
	N	≥1 visit[1], % (n)	Recommended per year[2]	Met[3],% (n)	Mean	Median	95% CI	
							LL	UL
1. Neuromuscular and rehabilitation management								
Neuromuscular clinical visit*	84	95.2 (80)	2x	86.9 (73)	3.2	3.0	2.7	3.7
Physiotherapy visit	84	92.9 (78)	2x	88.1 (74)	76.3	52.0	56.0	93.7
Occupational visit	84	78.6 (66)	2x	61.9 (52)	5.9	2.0	2.1	9.7
Muscle strength assessment	81	65.4 (53)	2x	38.3 (31)	2.9	1.0	0.2	5.5
Range of motion assessment								
Lower extremity								
All individuals	82	68.3 (56)	2x	32.9 (27)	1.3	1.0	1.0	1.5
Ambulatory	13	100.0 (13)	2x	69.2 (9)	2.9	3.0	1.6	3.2
Non-ambulatory	65	64.6 (42)	2x	27.7 (18)	1.0	1.0	0.0	4.0
Upper extremity								
All individuals	82	68.3 (56)	2x	31.7 (26)	1.3	1.0	0.9	1.6
Ambulatory	13	84.6 (11)	2x	53.8 (7)	2.3	2.0	1.0	3.6
Non-ambulatory	65	66.2 (43)	2x	29.2 (19)	1.2	1.0	0.8	1.6
Functional tests								
Lower extremity								
Ambulatory	13	76.9 (10)	2x	53.8 (7)	1.8	2.0	2.1	1.4
Upper extremity								
All individuals	82	57.3 (47)	2x	34.1 (28)	2.8	1.0	0.0	5.7
Ambulatory	12	92.3 (12)	2x	53.8 (7)	2.5	1.8	1.1	3.1
Non-ambulatory	60	52.3 (34)	2x	32.3 (21)	3.1	0.0	0.4	6.8
2. Corticosteroid management								
Monitoring								
Over- or underweight (weight)	76	83.1 (61)	2x	50.7 (38)	3.6	2.0	1.7	5.5
Growth retardation (height)	72	63.9 (46)	2x	29.2 (21)	2.0	1.0	0.5	3.5
Hypertension (blood pressure)	73	91.8 (67)	2x	67.1 (49)	5.8	2.0	0.3	11.3
Glucose intolerance (glucose test)	71	38.0 (27)	?	26.8 (19)	1.3	0.0	0.6	1.9
Cataracts (ophthalmologist)	83	14.5 (12)	1x	14.5 (12)	0.4	0.0	0.1	0.6
Bone demineralization or fracture risk								
Vitamin D	77	35.1 (27)	1x	35.1 (27)	0.6	0.0	0.4	0.9
DEXA scan	78	29.5 (23)	1x	29.5 (23)	0.3	0.0	0.2	0.5
3. Psychosocial management								
Psychiatrist visit	84	5.6 (5)	NA	NA	0.1	0.0	0.0	0.2
Psychologist visit	83	20.5 (17)	NA	NA	0.7	0.0	0.2	1.2
Remedial educationalist visit	84	10.7 (9)	NA	NA	0.3	0.0	0.0	0.5
General psychological examination	75	12.0 (9)	NA	NA	0.2	0.0	0.1	0.2
Neuropsychological examination	75	9.3 (7)	NA	NA	0.1	0.0	0.0	0.2
4. Orthopaedic management								
Orthopedist visit	84	40.5 (34)	1x	40.5 (34)	0.9	0.0	0.5	1.2
Spinal radiography	74							
Ambulatory	13	69.2 (9)	Indication	NA	0.9	1.0	0.3	1.6
Non-ambulatory	61	49.2 (30)	1x**	49.2 (30)	0.7	0.5	0.5	0.9
5. Respiratory management								
Respiratory clinical assessment	79							
Ambulatory	13	84.6 (11)	1x	84.6 (11)	1.3	1.0	0.7	1.9
Non-ambulatory	66	74.2 (49)	2x	34.8 (23)	1.3	1.0	1.0	1.6
6. Cardiac management								
Cardiologist visit								
All individuals	84	95.2 (80)	NA	NA	1.6	1.0	1.4	1.9
< 10 years of age	7	85.7 (6)	Once baseline	NA	1.3	1.0	0.6	2.0
≥ 10 years of age	77	96.1 (77)	2x	49.4 (38)	1.7	1.0	1.4	2.0
ECG								
< 10 years of age	7	100.0 (7)	1x per 2 years	100.0 (7)	1.3	1.0	0.8	1.7
≥ 10 years of age	74	97.4 (75)	1x	97.4 (75)	1.5	1.0	1.2	1.8
ECHO								
< 10 years of age	7	100.0 (7)	1x per 2 years	100.0 (7)	1.3	1.0	0.8	1.7
≥ 10 years of age	77	90.9 (70)	1x	90.9 (70)	1.4	1.0	1.2	1.8

Legends: Abbreviations: confidence interval (CI), lower limit (LL), upper limit (UL). [1]Percent that had ≥ 1 visit per year for the outcome measure.[2]Recommended visit frequency per year based on the care considerations [3]Percentage of patient that meets the visit frequency recommendation. [4]Average number of annual visits. *A neuromuscular visit is defined as a visit to either a neurologist or a rehabilitation physician. *recommendations are based on the curvature, which is unknown in our study population. The recommendation for < 20° curves is 1x year, ≥ 20° is 2x year.

Table 4
Satisfaction with care components

	N	Very satisfied% (*n*)	Fairly satisfied% (*n*)	Neutral % (*n*)	Fairly dissatisfied (*n*)	Dissatisfied % (*n*)
Overall health care	81	42.0 (34)	46.9 (38)	6.1 (5)	2.5 (2)	2.5 (2)
(Semi-) annual follow up visit	75	45.3 (37)	38.7 (29)	8.0 (6)	4.0 (3)	0.0 (0)
Care (-related matters) provided by (local) government and health insurance	81	19.8 (16)	53.1 (43)	18.5 (15)	8.6 (7)	0.0 (0)
Patient involvement in medical decisions	82	73.2 (60)	20.7 (17)	2.4 (2)	3.7 (3)	0.0 (0)

done annually in 69.2% of ambulatory participants and in 49.2% of non-ambulatory participants, while under 18 years of age this is 83.9%. Table 3.4 shows the proportion of participants who met the visit frequency for orthopedic management recommendation in the care considerations.

The majority of participants found information received from a health care professional about scoliosis and contractures sufficient (85.2% and 77.5% respectively). A smaller percentage of participants found it insufficient or did not receive information about the subject (14.8% and 15.1% respectively).

Respiratory management

The percentage of ambulatory participants who met the recommended visit frequency for a respiratory clinical assessment is 84.6%, whereas for non-ambulatory participants the percentage is 34.8%. Table 3.5 shows the proportion of participants meeting the visit frequency for respiratory management recommendation in the care considerations.

The majority of participants found information received from a health care professional about respiratory difficulties during the disease sufficient (85.2%). A smaller percentage of participants found it insufficient or did not receive information about the subject (12.1%). Most participants received an annual flu vaccine. Of the participants 72.6% had seen a pulmonologist ≥ 1 in the past year, and 88.1% of non-ambulatory participants visited a home ventilation center.

Cardiac management

Table 3.6 shows the proportion of participants meeting the visit frequency for cardiac management recommendation in the care considerations. The majority of participants found information received from a health care professional about cardiac problems during the disease sufficient (81.5%). A smaller percentage of participants found it insufficient or did not receive information about the subject (14.8%).

Satisfaction and patient involvement in care

Overall, the participants were satisfied with the care they received: of the participants 88% is very or fairly satisfied with the overall health care they receive. Similar percentages were found in satisfaction with the follow up visits and patient involvement in medical decisions, see Table 4. The open questions revealed that participants found that procedures for requesting aids (such as wheelchairs) take too long. Also, participants felt that the care could be organized more efficiently and communication between healthcare centers could be improved.

DISCUSSION

The purpose of this study was to investigate the current care of patients with Duchenne muscular dystrophy (DMD) in the Netherlands and to what extent the care complies with the international care considerations of 2010. Overall, we found that practice aligns well with the care considerations but there are also several areas in which implementation is suboptimal.

The care considerations underline the importance of regular visits to a neuromuscular specialist and several neuromuscular assessment are to be conducted such as muscle strength, assessment of range of motion and functional tests. In our cohort, the majority of the participants met the recommendation of a twice a year visit to a neuromuscular specialist (86.9%). Compliance to neuromuscular assessments ranged from 31.7% to 53.8%, with a higher compliance in ambulant participants compared to non-ambulant participants, which corresponds to sub-optimal compliance in other countries [12, 14]. This is a point of concern, as regular monitoring for decline in function and (asymmetric) contractures is imperative for early interventions. When patients become non-ambulant, lower extremity function and range of motion still plays a role in for example sitting stability. Hence, it is important to keep up the functional assessments throughout the disease phases. However, it becomes more difficult when the transfer from a wheelchair to a treatment table is no longer a simple option. The measurement protocol should take into account that tests in this stage can also be done while seated in the wheelchair. Another possible explanation for the lower compliance is that there is relatively less experience among health care providers in the non-ambulatory stage. This highlights the importance of attention to the transitions of care across the lifespan, which is one of the new topics in the revised care considerations of 2018 [11].

Access to professional physiotherapy in the Netherlands is high with 89% of participants having weekly physiotherapy sessions of with a total duration of ≥ 60 minutes for 49.0% of these participants. This is similar to Germany and Denmark and higher compared to the UK and Eastern Europe countries [13, 15]. Besides physiotherapists, occupational and speech and language therapists play an important role in activities in daily life, aids and devices, communication, social participation and eating and drinking. Furthermore, adequate information about the disease course and an anticipatory approach is vital for patients and their families. Our data show that the majority participants was satisfied with the information they receive. Health care providers should ensure patients receive all information so patients and their parents can anticipate on events to be expected in the course of DMD, relating to medical care and future education and living plans.

Monitoring for side effects of long-term corticosteroid use shows compliance rates ranging from 16.3% for an annual cataract screening to 68.8% for twice a year monitoring of blood pressure for the participants that use corticosteroids. Measuring weight, height, blood pressure and bone health is also of importance for the whole population (Table 3.2). Most assessments are being met in $< 50\%$ of the study population, which corresponds to other studies [14]. The low compliance rates for some of the assessments may be explained by the numerous assessments suggested by the care considerations and it may not be feasible for care providers to implement all assessments. We do see higher percentages of participants reporting annual monitoring for weight, height and blood pressure (83.1%, 63.9% and 91.8% resp.), however twice a year monitoring should be pursued, as side effects of corticosteroid can impair functional living and quality of life.

The clinical assessments for cardiac management appear to be performed as recommended in the care considerations. This is also consistent with other studies [14]. The compliance to an annual respiratory assessment for ambulant participants was high. However, in the non-ambulatory group, only 34.8% of participants had the recommended twice a year respiratory assessment. Other authors report similar proportions of compliance for both ambulatory and non-ambulatory patients [12, 15, 22]. Frequent monitoring of respiratory function is necessary to facilitate an anticipatory approach to manage complications [9]. However, when patients require noninvasive ventilation, not all suggested tests are clinically relevant anymore and might only cause burden on the patient. This could (partially) explain the low compliance rate to twice a year testing in the non-ambulatory phase in our study. In the Netherlands, centers for home ventilation perform respiratory monitoring as a part of their treatment. Given that the majority of our participants reported at least one visit to a center for home ventilation, it seems that the compliance of monitoring respiratory function is higher than the percentage suggests.

A spinal radiography for ambulant patients is only recommended when indicated. In the 2010 guideline it is recommended that if there is a scoliosis of more than 20 degrees the monitoring should be done twice a year. However, we had no information about the degree of curvature of the spine, hence we could not study the compliance for this recommendation. We did find that 69.2% of ambulatory participants and 49.2% of non-ambulatory participants had a spinal radiography in the past year. This is higher than Vry et al., who reported a mean percentage of 20.2% of patients who had a spinal inspection [13], but comparable with the findings of Andrews et al. [14]. Monitoring the spinal curvature is important for indication for surgery, sitting balance and indication for wheelchair adjustments. Also, one should be aware of microfractures in the spine or vertebrae deformations.

In our study it was difficult to evaluate compliance rates to psychosocial care, since we could not calculate recommended frequencies as it is only indicated in the 2010 guideline at the time around diagnosis, before entering school and after a change in function, and our data only contained visits in the past year. Also, it might be difficult for patients or parents to recall screening on mental health problems, since this often is done during a follow up visit, but not specifically by a psychosocial professional. As the life expectancy is increasing, increased effort must be made to further integrate psychosocial management to help optimize the quality of life throughout all stages of the disease [23].

Reflecting on the areas where compliance is suboptimal, it is essential to take into account the shared care organization in the Netherlands. All health care providers and centers involved in DMD care should know their role and responsibilities. In the Netherlands, the Duchenne Center Netherlands (DCN) was initiated in 2016 to take the leading role in the implementation process of the care considerations. It is a collaboration between three Dutch DMD expert centers who work together with other academic medical centers, centers for home ventilation and rehabilitation centers. The DCN also joins forces with patient organizations and health care professionals throughout the country in the field of care, treatment and research. Insight in the current compliance is one of the first steps in eventually fully implementing the guidelines within the Dutch care system.

We are mindful of limitations of this study due to the cross-sectional design and use of a self-reported questionnaire. Self-reporting questionnaires carry a risk recall bias or miscomprehension of questions. Hence, participants may have overlooked healthcare visits or assessments which may have led to an underestimation. Furthermore, those who are more likely to be compliant with care recommendations are also more likely to complete a survey and thus there may be a bias away from those most in need of extra support to ensure compliance due to social factors, language barriers, etc. in accessing the system. We excluded 3 participants that were ambulant above 16 years of age, which means there is a risk that we excluded the intermediate phenotype or boys that walked longer due to corticosteroid use. Also, the response rate was 21.3%, which is lower than most other self-report survey studies where the response rate ranged between 42 and 63.3% [12, 13, 15]. This might be because nowadays patients are often invited to participate in studies, which can cause an overload next to their regular health care appointments [24]. The low response rate should also be considered in the light of prevalence of DMD in the Netherlands. When comparing the number of inhabitants for example between the Netherlands and Germany, Germany has more than 4 times more inhabitants, and prevalence of DMD is comparable. However, in the study of Landfeldt [12] the number of respondents is 173 versus 84 in the Netherlands. Thus a response rate only gives information on the population that was invited, while in our study we tried to reach out to all DMD patients in the Netherlands.

The mean age of diagnosis in our study population (4.7 years, SD = 2.6), was within the range of 4.3 to 4.9 years found in other European countries and the US [13, 20, 21]. This means that our population reflects to some extend the Dutch population of DMD patients. Our cohort consisted of mainly participants in the non-ambulatory stage and the mean age of the total group was relatively high. Although this skewed our study population and therefore provided less information of provided care in the ambulant stage, boys/men in the non-ambulatory phase are the ones with the most experience in care as they require more extensive care than younger patients. The high age of our study population may explain the high percentage of muscle biopsies which were reported. Moreover, it is not possible to cover all aspects of DMD addressed in the care considerations, as changes in older patients are slower, thus the need for visits is lower. This could lead to some extent also the lower percentage of yearly visits. We chose to cover a wide range of different disease aspects to give an overall insight in compliance.

We showed that the shared care for DMD in the Netherlands aligns well with the care considerations, but we also identified several areas which need improvement. While some countries choose to provide all aspects of DMD care in one center, countries working according to a shared care system should facilitate easy and low-threshold communication between health care centers and appoint a coordinating role. It is important that results obtained from visits and assessments are shared with the whole treatment team. Scheduled assessments can be divided between visits in different health care centers which can alleviate (time) pressure for both the patient and the professional. To implement new insights and knowledge efficiently, a structured (inter-) national communication and education network will be helpful. The DCN initiated national steering groups for each care discipline to discuss and implement the care considerations nationally and investigated barriers to adherence to the care considerations among health care providers who are involved in care for DMD in the Netherlands (25). The steering groups offer the opportunity to anticipate on the latest developments and new insights in care. Joining forces (inter)nationally can further improve compliance and quality of care, to eventually translate to an optimal quality of life for patients with DMD.

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CONFLICTS OF INTEREST

Authors declare no conflicts of interest.

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