Pediatric Home Care Patients Study
Outside Section 132

Prepared for:
Commonwealth of Massachusetts
Center for Health Information and Analysis

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1.0 Executive Summary

The Center for Health Information and Analysis (CHIA) has been charged in the Acts of 2017, Chapter 47, Section 132 (Chapter 47), with providing "a report related to costs associated with the hospitalization of medically complex pediatric home care patients." BerryDunn was retained to assist CHIA in conducting the study.

In 2015, approximately 690 children with medical complexity (CMC) in Massachusetts received skilled nursing care services from MassHealth provided through the University of Massachusetts Medical School Commonwealth Medicine Community Case Management Program (CCMP).[i] These children are at risk for institutionalization, and most of them would be institutionalized without the CCMP. The CCMP allows CMC to receive home- and community-based services through the CCMP. All CCMP children are eligible for continuous skilled nursing (CSN) services, which are nursing services provided to patients in their homes.

CMC face disability, vulnerability, and dependence on technology, and require intensive care coordination in order to achieve optimal outcomes.[1] The CMC population is growing as a result of medical improvements in pediatric care that have led to a substantial increase in the number of children surviving previously fatal complex conditions.[2] Children in the Commonwealth's CCMP are a subset of the larger Massachusetts CMC population.

The above-cited Chapter 47 requires CHIA to address four questions related to the CCMP population:

1. The number of medically complex pediatric home care patients—including those who have aged into adulthood—who are hospitalized annually, and the length of their stay
2. The estimated cost to MassHealth of the annual hospitalization of medically complex pediatric home care patients
3. The estimated cost to private payers of the annual hospitalization of medically complex pediatric home care patients
4. A cost analysis comparing CSN service costs to the cost of likely avoidable hospitalizations

BerryDunn used data provided by MassHealth on authorization for and use of CSN services, which allowed identification of the relevant population of children. Additional cost analysis, including inpatient service utilization, was conducted using the Massachusetts All-Payer Claims Database (MA APCD).

[i] In Massachusetts the Community Case Management program is commonly referred to as "CCM." In this document, the program is frequently referred to along with the children with medical complexity, or "CMC," population. To make the distinction visually easier for the reader, we will use the abbreviation "CCMP" to refer to the Community Case Management program throughout.

The first question regarding the number of CSN patients hospitalized and their hospital length of stay (LOS) is addressed in Table E-1, below. This measure includes hospitalizations covered by commercial insurance, MassHealth, or some combination thereof.

Table E-1: Number of CCMP Members Receiving Pediatric Home Care Hospitalized Annually and Length of Stay (Combined Commercial and MassHealth Utilization Included, Medicare-Eligible Members Excluded)

Calendar Year of Admission	CSN Members Admitted One or More Times	Members with Paid CSN Utilization	Length of Stay						
			Mean	Median	Min	Max	25th Pctile	75th Pctile	Interquartile Range (75th Pctile – 25th Pctile)
2013	317	615	11	4	1	973	2	8	6
2014	328	673	9	4	1	475	2	8	6
2015	335	686	7	4	1	211	2	8	6

The second question regarding the hospitalization costs of these members to MassHealth only is addressed in Table E-2, below, and the third question, costs to commercial insurers only, is answered in Table E-3 (on the following page). The sum of unique members reported in Tables E-2 and E-3 is greater than the total number of unique members reported in Table E-1 because some members' hospitalization utilization was paid for by a combination of commercial payers and MassHealth.

Table E-2: Estimated Annual Cost to MassHealth of Hospitalization of Members Receiving CCMP Pediatric Home Care Services (Commercial Utilization Excluded, Medicare-Eligible Members Excluded)

Calendar Year of Admission	Unique Users	MassHealth Hospitalization Claims Expense Paid
2013	209	$ 8,694,604
2014	226	$ 11,077,337
2015	231	$ 12,936,385

Table E-3: Estimated Annual Cost to Commercial Payers of Hospitalization of Members Receiving CCMP Pediatric Home Care Services (MassHealth Utilization Excluded, Medicare-Eligible Members Excluded)

Calendar Year of Admission	Unique Users	Hospitalization Claims Expense Paid
2013	135	$ 11,391,219
2014	127	$ 11,035,760
2015	133	$ 10,150,978

The fourth and last question (requiring a cost analysis comparing CSN service costs to the cost of likely avoidable hospitalizations) is a more complicated question that BerryDunn addressed by:

- Reviewing previously conducted research studies estimating the level of potentially avoidable admissions in the CMC population
- Drawing from these prior studies a percentage range of hospitalization costs related to potentially avoidable admissions and applying that to hospitalization costs for children in the CCMP
- Measuring the costs of CSN services from MassHealth data
- Analyzing patterns of CSN authorization and usage in the CCMP population

The research literature about potentially avoidable admissions is focused on the broader CMC population; there are valid research results on the number of avoidable admissions related to ambulatory care sensitive conditions and on those related to avoidable readmissions. In both cases, the research finds that the degree of avoidable admissions is lower among the CMC population than the general population. It is difficult to quantify the proportion of admissions for CCMP members that are potentially avoidable. Research results on the broader CMC population suggest that the proportion of all admissions that are potentially avoidable is almost certainly below 20%, likely below 10%, and possibly much lower. Wherever in that range the potentially avoidable admissions number might be, the number of admissions actually avoidable will be lower, as the research indicates that many admissions that appear potentially avoidable would be determined to not be avoidable after chart review.

A conservatively high estimate of potentially avoidable admissions can be calculated by making the following three assumptions:

- 10% of inpatient admissions are potentially avoidable
- All of the potentially avoidable admissions are in fact avoided

- That avoiding an admission does not result in avoidable costs for other non-hospitalization services provided in lieu of the hospitalization services, such as facility-based skilled nursing rehabilitation costs

On net, these assumptions result in a simple multiplication of the inpatient costs by the 10% factor. If we apply the 10% factor to the costs in Tables E2 and E3, the resulting very conservative savings estimates are $1.3 million for MassHealth (10% of the 2015 MassHealth expenditure total in Table E-2) and $1.0 million for commercial payers (10% of the 2015 commercial expenditure total in Table E-3), for a total of $2.3 million.

Table E-4, below, shows the costs of CSN for CCMP members receiving pediatric home care services (which are almost exclusively paid for by MassHealth).

Table E-4: Annual Medicaid Expenses for CSN Services for Members Receiving CCMP Pediatric Home Care Services (Procedure Codes T1002 and T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	Unique Users	CSN Claims Expense Paid	Annual Cost Per User
2013	615	$ 62,630,022	$ 101,837
2014	673	$ 67,762,298	$ 100,687
2015	686	$ 67,668,317	$ 98,642

The CSN service costs, at approximately $100,000 per user per year, are approximately twice the level of annual hospitalization costs per admitted patient. Because virtually all CCMP children receive CSN services, and approximately half of CCMP children are admitted each year, the CSN costs per year per CCMP child are on average approximately four times the costs per child of inpatient services. Because all CCMP children are eligible for CSN services, this spending level helps avoid dramatically higher costs, as CSN costs on average approximately $450 per day. The acute inpatient care, summarized in the tables above, costs on average approximately $3,000 per day. While this acute level of care is likely be more resource-intensive than an average day in a full-time institutional setting, for the many CCMP children who would otherwise be institutionalized, the $450 per day for CSN services saves an amount per day in institutionalization costs that would be much higher than $450.

There is a wide range of CSN hours authorized per child, and different proportions of authorized services actually delivered across the CCMP population. The proportion of authorized services received is much lower for CCMP members with fewer authorized hours than CCMP members with a higher number of authorized hours. The 10% of CCMP members with the lowest number of authorized CSN hours had, on average, about 15% of their authorized hours filled. In contrast, the 10% of CCMP members with the highest number of authorized CSN hours had, on average, all of their authorized hours filled.

2.0 Medically Complex Pediatric Home Care in Massachusetts

CHIA has been charged with providing a report related to costs associated with the hospitalization of medically complex pediatric home care patients.[ii] The full text of the study requirements, as they are provided in the Acts of 2017, Chapter 47, Section 132 (Chapter 47) - making appropriations for fiscal year 2018 - can be found in Appendix A. BerryDunn was retained to assist CHIA in conducting the study.[iii]

In 2015, approximately 690 children with medical complexity (CMC) in Massachusetts received skilled nursing care services from MassHealth provided through the University of Massachusetts Medical School Commonwealth Medicine Community Case Management Program (CCMP),[iv] These children are at risk for institutionalization, and most of them would be institutionalized without the CCMP. The CCMP allows CMC to receive home- and community-based services through the CCMP. All CCMP children are eligible for continuous skilled nursing (CSN) services, which are nursing services provided to patients in their home.

CMC face disability, vulnerability, and dependence on technology, and require intensive care coordination in order to achieve optimal outcomes.[1] The CMC population is growing as a result of medical improvements in pediatric care that have led to a substantial increase in the number of children surviving previously fatal complex conditions.[2] Children in the CCMP are a subset of this larger CMC population.[v]

CMC may have multiple and varied diagnoses, and may have a congenital or acquired multisystem disease, a severe neurologic condition with marked functional impairment, and/or technology dependence for activities of daily living.[3] Even CMC with the same diagnoses often

[ii] An Act Making Appropriations for the Fiscal Year 2018 for the Maintenance of the Departments, Boards, Commissions, Institutions and Certain Activities of the Commonwealth, for Interest, Sinking Fund and Serial Bond Requirements and for Certain Permanent Improvements, 2017 Mass. Acts, Chapter 47.

[iii] CHIA also conducted regular bi-weekly calls to consult with the Massachusetts Pediatric Home Nursing Campaign and the Home Care Alliance of Massachusetts, Inc. during the preparation of the report.

[iv] In Massachusetts the Community Case Management program is commonly referred to as "CCM." In this document, the program is frequently referred to along with the children with medical complexity, or "CMC," population. To make the distinction visually easier for the reader, we will use the abbreviation "CCMP" to refer to the Community Case Management program throughout.

[v] Although CMC represent approximately 0.5% of all United States children, studies estimate that they account for as much as one-third of child health expenditures nationally (Coller R, Nelson B, Sklansky D, et.al. Preventing Hospitalizations in Children with Medical Complexity: A Systematic Review. Pediatrics. November 2014. Accessed 26 February 2018: http://pediatrics.aappublications.org/content/early/2014/11/05/peds.2014-1956). Data from Medicaid database including 2011 medical claims across the care continuum for 3,686,635 Children's Health Insurance Program (CHIP) enrollees aged 0-18 in 12 states representing all US geographical regions, ages 0-18 found that hospital care accounted for 47.2% of the health care spending for CMC. For 2011 the database contained medical claims across the care continuum for 3,686,635 Medicaid enrollees in 12 states, ages 0-18. It included children enrolled through the Children's Health Insurance Program (CHIP) from twelve states that represented all US geographical regions.

have different presentations and needs. Nonetheless, there are four commonalities that characterize CMC:[4]

- Chronic and severe health conditions
- Substantial health service needs
- Major functional limitations
- High health resource utilization

In Massachusetts, children in the CCMP, who represent approximately 0.015% of Massachusetts children, are among the highest-need CMC. The above-cited Chapter 47 requires CHIA to address four questions related to the CCMP population:

1. The number of medically complex pediatric home care patients—including those who have aged into adulthood—who are hospitalized annually, and the length of their stay
2. The estimated cost to MassHealth of the annual hospitalization of medically complex pediatric home care patients
3. The estimated cost to private payers of the annual hospitalization of medically complex pediatric home care patients
4. A cost analysis comparing CSN service costs to the cost of likely avoidable hospitalizations

These four questions are addressed in sections 2.1 through 2.4, below.

2.1 Number of Patients Hospitalized Annually and Length of Stay

The first study requirement calls for an estimate of "the number of pediatric home care patients, including those who have aged into adulthood, who are hospitalized annually and the length of their stay."[5] To support this analysis, BerryDunn reviewed a data set of prior authorizations and claims for 1,556 MassHealth medically complex home care patients, defined as all CCMP members who had at least one prior authorization for CSN services in the period January 2011 to March 2018. The data set included all MassHealth prior authorizations and claims for CSN services (HCPCS codes T1002 and T1003), Personal Care services (PCA services, HCPCS code T1019), and Home Health Aide services (HH services, HCPCS code G0156) for this medically complex home care population. This analysis defines the population of "pediatric home care patients, including those who have aged into adulthood" as the 997 members in the MassHealth data extract who had at least one prior authorization for CSN services before reaching age 22 during the period for which Massachusetts All Payer Claims Database (MA APCD) Release 5.0 data are available (2011 – 2015).

To estimate hospital utilization and costs, BerryDunn extracted claims and eligibility data for these MassHealth pediatric home care members from its MA APCD Release 5.0[6] commercial

and Medicaid data extract.[vi] BerryDunn matched approximately 99% of the 997 CCMP members with at least one pediatric prior authorization for CSN in the 2011 to 2015 period covered by the MA APCD Release 5.0 extract to data in the MA APCD extract.[vii] All MA APCD claims for services occurring on or after the start date of a member's first CSN prior authorization in the study period were included in the analysis.

The MA APCD extract does not include Medicare data. Accordingly, this analysis excluded the 2% – 3% of MassHealth CMC whose MA APCD eligibility records indicated dual Medicaid and Medicare eligibility at the time of service.[viii] Including Medicaid (or commercial) expense or utilization data for Medicare-eligible patients without having Medicare paid claim data would skew the per-person hospitalization results significantly downward, as Medicare covers the vast majority of hospitalization expenses for its beneficiaries.

Table 1, on the following page, displays the number of CCMP children hospitalized (admitted) annually during calendar years 2013[ix] – 2015 and statistics on their lengths of stay, regardless of whether costs were paid for by MassHealth, commercial insurance, or in part by both. Approximately half of pediatric home care patients were hospitalized each year for all causes. Half of these hospitalizations lasted four days or less, resulting in a median length of stay of four for all three years. However, owing to a small number of extremely long hospitalizations, the average (mean) length of stay is over twice as long as the median stay in two out of three years, ranging from seven to eleven days.

There are also other substantial costs associated with serving these members in the community that were not included in the present study, including, but not limited to, durable medical

[vi] CHIA provided eligibility data extracts including members' unencrypted Medicaid identification numbers to BerryDunn through secure means to allow matching to the MassHealth data extract. BerryDunn then matched the medically complex home care population's MA APCD eligibility records to MA APCD claims using the MA APCD Release 5.0 member linking identifier, member year of birth, and member month of birth.

[vii] MA APCD results may slightly understate hospitalization utilization for the medically complex home care population to the extent hospitalization claim data for these members is not reported in the MA APCD or is not matched to population members' Medicaid identifiers in the MA APCD. In addition, one national commercial insurance carrier's data were excluded from the analysis due to known data quality issues. These issues are not judged to be material to the results presented.

[viii] BerryDunn considered a member Medicare eligible on all days of any authorization span with a Medicare Part A indicator of "yes" (IND_MEDCARE_A='Y') reported in the MassHealth Enhanced Eligibility (MHEE) table of its MA APCD Release 5.0 extract. BerryDunn then excluded claims for services occurring (defined by service begin date or admission date) on Medicare-eligible days and allocated authorization data for Medicare-eligible days.

[ix] The study requirement to include members who have aged out of the pediatric cohort results in a CMC population that grows over time, with the effect being most pronounced in the early years of the data extract. Therefore, 2011 and 2012 utilization results are understated, and are thus excluded from the time series results tables.

equipment (DME), other in-home care services (e.g., personal care aide services), and office visits.

Table 1: Number of CCMP Members Receiving Pediatric Home Care Hospitalized Annually and Length of Stay (Combined Commercial and MassHealth Utilization Included, Medicare-Eligible Members Excluded)

Calendar Year of Admission	CSN Members Admitted One or More Times	Members with Paid CSN Utilization	Length of Stay						
			Mean	Median	Min	Max	25th Pctile	75th Pctile	Interquartile Range (75th Pctile – 25th Pctile)
2013	317	615	11	4	1	973	2	8	6
2014	328	673	9	4	1	475	2	8	6
2015	335	686	7	4	1	211	2	8	6

2.2 Estimated Hospitalization Cost to MassHealth

The second study requirement requires measurement of "…the estimated cost to MassHealth of the annual hospitalization of medically complex pediatric home care patients." Table 2, below, displays the estimated annual cost to MassHealth (both fee-for-service MassHealth expenses and Medicaid managed care expenses) of the subset of those hospitalizations summarized in Table 1 that were paid for in part or in total by MassHealth.[7]

Table 2: Estimated Annual Cost to MassHealth of Hospitalization of Members Receiving CCMP Pediatric Home Care Services (Commercial Utilization Excluded, Medicare-Eligible Members Excluded)

Calendar Year of Admission	Unique Users	MassHealth Hospitalization Claims Expense Paid
2013	209	$ 8,694,604
2014	226	$ 11,077,337
2015	231	$ 12,936,385

Commercial coverage also paid for large amounts of inpatient care; these costs are summarized in the next section. Note that some individuals included in Table 2 also had some costs paid for by commercial insurance; those individuals are also included in the "unique users" in the next section's Table 3, along with their costs paid for by commercial insurance. For example, in 2015, 29 members had inpatient costs paid for by both MassHealth and commercial insurers, making the sum of the 231 in Table 2 and the 133 in Table 3 larger by 29 than the 335 unique individuals in Table 1.

2.3 Estimated Hospitalization Cost to Private Payers

The third study requirement is to calculate "…the estimated cost to private payers of the annual hospitalization of medically complex pediatric home care patients." Table 3, below, displays the estimated annual cost to Massachusetts commercial health insurers of the subset of hospitalizations summarized in Table 1 paid for in part or in total by commercial payers.[8]

Table 3: Estimated Annual Cost to Commercial Payers of Hospitalization of Members Receiving CCMP Pediatric Home Care Services (MassHealth Utilization Excluded, Medicare-Eligible Members Excluded)

Calendar Year of Admission	Unique Users	Hospitalization Claims Expense Paid
2013	135	$ 11,391,219
2014	127	$ 11,035,760
2015	133	$ 10,150,978

As noted, Table 2 contains only MassHealth inpatient claim expense, and Table 3 contains only commercial inpatient claim expense, but because some admissions were paid for in part by both commercial and MassHealth, the numbers of unique users in Tables 2 and 3 sum to more than the unique users in Table 1.

2.4 Continuous Skilled Nursing Service Costs Compared to Cost of Likely Avoidable Hospitalizations

The fourth and final study requirement is to conduct "…a cost analysis comparing continuous skilled nursing service costs to the cost of likely avoidable hospitalizations." This question is more complicated than questions 1 – 3, and is addressed below by taking the following steps:

- Reviewing previously-conducted research studies estimating the level of potentially avoidable admissions in the CMC population (addressed in 2.4.1, below)
- Drawing from these prior studies a percentage range of hospitalization costs related to potentially avoidable admissions and applying that to hospitalization costs for children in the CCMP (also addressed in 2.4.1)
- Measuring the costs of CSN services from MassHealth data (addressed in 2.4.2)
- Analyzing patterns of CSN authorization and usage in the CCMP population (addressed in section 2.5, below)

2.4.1 Literature on Potentially Avoidable Admissions in the CMC Population

There is no consensus about how to define or reduce likely avoidable hospitalizations for CMC. A survey of the literature indicates that researchers take one of three approaches in an attempt to define and measure avoidable hospitalizations for CMC: admission for ambulatory care

sensitive conditions (ACSCs), readmissions, or investigator-defined criteria.[9] Although each approach has limitations, the majority of research on the CMC population supports that postsurgical patients, those with neurological disorders, and those with medical devices have higher avoidable hospitalization rates, as do those with public insurance and nonwhite race/ethnicity.[10] Passive smoke exposure, non-adherence to medications, and lack of follow-up after discharge are additional risks for avoidable hospitalizations.[11] Alternatively, patients who receive home visits, care coordination, chronic-care management, and continuity of care across settings have fewer potentially avoidable hospitalizations.[12]

2.4.1.1 Ambulatory Care Sensitive Conditions

ACSCs are conditions for which timely and effective outpatient care can potentially prevent the need for hospitalization.[13] Research has found that hospitalizations for ambulatory ACSCs are less common in more complex patients, and may not apply to this population.[14]

Two national studies have found ACSC hospitalizations to be less common for more complex pediatric patients.[15,16] In a retrospective cohort analysis of 317,643 patients (n=579,504 admissions), as readmission frequency increased from 0 to 4 or more annually, the percentage of hospitalizations associated with an ACSC decreased (from 23.1% to 14%).[17] In an analysis of the 2006 Kids' Inpatient Database (weighted N-7,558,812), ICD-9-CM codes for standard ACSCs were used to identify potentially preventable hospitalizations for pediatric patients. Fewer children admitted for an ACSC hospitalization had a complex chronic condition than among those with a non-ACSC hospitalization (10.8% vs 16.1%).[18] Given that the CCMP population in this study is among the most complex of the CMC population, this suggests the proportion of ACSC avoidable hospitalizations for the CCMP population is probably below the 10.8% for the overall CMC population.

In addition to being less common in CMC, hospitalization for some conditions categorized as ACSCs for a general population may be unavoidable when they do occur in the CMC population. For example, gastroenteritis and dehydration hospitalizations may be avoidable in the general population, but they may not be avoidable for a child with medical complexity with a multi-organ system chronic illness, inability to tolerate enteral feedings, or a metabolic disorder.[19] In a study of 81 patients with spina bifida and a hospitalization for a urinary tract infection (which is classified as an ACSC), 73 had an ambulatory claim in the 7 days before hospitalization.[20] The study raises the question of how truly "ambulatory care sensitive" urinary tract infections are in CMC when over 90% of the patients received care the week before admission.[21] This suggests the 10.8% of admissions that are ambulatory care sensitive among the CMC population using the standard definition of ACSC might well be significantly lower in the CCMP population.

Research also suggests that CMC may have other diagnoses that should be considered ambulatory care sensitive that are not included within the current ACSC set—diagnoses for which optimal outpatient management could potentially prevent hospitalizations.[22] BerryDunn is

not aware of any research that has attempted to define or quantify these CMC-specific avoidable admissions systematically.

On balance, it is difficult to quantify the proportion of admissions that are potentially avoidable owing to being ASC, but it is highly likely to be below 20%, very likely to be below 10%, and very possible to be much lower than that.

2.4.1.2 Readmissions

Readmissions, in combination with other variables, are often used as an indicator of preventable hospitalizations. For example, researchers attempt to identify avoidable hospitalizations by whether they occur within a certain timeframe postoperatively or if the readmission is for a diagnosis related to the same organ system as the previous hospitalization. One study developed a detailed five-point rating scale to rate preventability that four physicians utilized to perform independent retrospective chart reviews of 15-day readmission cases at a freestanding children's hospital.[23] The physicians found that 20% of 15-day readmissions were potentially preventable. The 15-day readmissions represented 8.5% of total admissions in the study period. The 20% of 15-day readmissions deemed potentially preventable therefore represented 1.7% of total admissions. Readmissions in children with malignancies were considered less preventable than those in children with other chronic illness (5.8% versus 25.8%). Readmissions following surgical admissions were considered more likely preventable than those following medical admissions (38.9% versus 15.9% of readmissions). Central venous catheter infections and ventricular shunt malfunctions accounted for 8.5% of all readmissions reviewed. During the chart reviews, the four physician-reviewers had difficulty reaching agreement on whether admissions were avoidable, which illustrates the need for further research to develop an agreed-upon standard to label a hospital admission as preventable or avoidable, and the limitations of administrative claim data in answering this question.

Despite the difficulty of labeling hospitalizations as avoidable, studies have found lower readmission rates in patients with a medical home or home health services. In a retrospective matched-cohort study of 2,783 hospitalized children receiving post-discharge home health services (a broader and generally less intensive definition than CSN services in Massachusetts) by BAYADA Home Health Care across 19 states and 7,361 matched controls not discharged to home health services from the Children's Hospital Association Case Mix database between January 2004 and September 2012, children discharged to home health experienced less hospital use than children with similar characteristics who did not use home health care.[24] At 12 months after the index admission, home health patients averaged fewer admissions (0.8 vs 1), fewer days in the hospital (6.4 vs 6.6), and lower hospital costs ($22,511 vs $24,194) compared with their matched controls.[25] In this study, the children receiving home health had a higher percentage of complex chronic conditions (68.5% vs 65.4%), technology assistance (40.5 vs 35.7%), and neurologic impairment (40.7% vs 37.3%).[26]

Based on the finding of the first study cited above, 1.7% of total admissions were potentially preventable readmissions. Assuming 2% of preventable admissions are avoidable readmissions

would be a conservatively high assumption. This would be in addition to the potentially avoidable ACSC admissions discussed in sub-section 2.4.1.1.

2.4.1.3 Investigator-Defined Criteria

The investigator-defined criteria approach utilizes retrospective chart reviews or observation in changes in hospitalization rates after an intervention. These types of studies are often designed without confirming reliability and validity, making interpretation of the results challenging.[27] Criteria definitions are unique and thus difficult to attempt to compare across studies. Even within investigator-defined criteria-based retrospective chart reviews, investigators may have difficulty reaching consensus on which admissions are truly avoidable.[28] These studies do not provide useful information for our assessment of potentially avoidable admissions in Massachusetts.

2.4.1.4 Implications for Estimates

Combining the implications of the discussion in the three preceding sub-sections, on balance it is difficult to quantify the proportion of admissions for CMC, and the highly complex subset of the CMC population represented by CCMP members, that are potentially avoidable. Taking into account both ACSC admissions and re-admissions, the total proportion preventable is almost certainly below 20%, likely below 10%, and possibly much lower. Whatever the potentially avoidable number might be, the actually avoidable number will be lower, as research indicates that many admissions that appear potentially avoidable would be determined to be not avoidable after chart review. In this analysis, the uncertainty is addressed by providing detail on the hospitalization costs by body system related to primary diagnosis, and application of a range of percentages that are potentially avoidable.

Identifying potentially avoidable admissions costs starts with summarizing admissions costs. Combining the hospitalization expense results for the MassHealth and commercial populations for the CCMP population in Tables 2 and 3 above yields the hospitalization expenses for *all* admissions shown in Table 4, below.

Table 4: Estimated Annual Cost to Commercial Payers and Medicaid of Hospitalization of CCMP Members Receiving Pediatric Home Care (Medicare-Eligible Members Excluded)

Calendar Year of Admission	Unique Users	Hospitalization Claims Expense Paid
2013	317	$ 20,085,822
2014	328	$ 22,113,097
2015	335	$ 23,087,362

Per-day combined Medicaid and commercial insurance expenses are shown in Table 5. The mean annual treatment days per user per year figures in the fifth column of Table 5 are larger than the mean and median lengths of stay reported in Table 1 because many members in the population have multiple admissions per year (in some cases more than ten). The length of stay

statistics in Table 1 summarize bed days per admission, while the mean units per user in Table 5 summarize the average number of bed days per member across all admissions in the year.

Table 5: Annual Medicaid and Commercial Payer Claim Expenses Per User Per Treatment Day (i.e., Per Bed Day) for Hospitalization of CCMP Members Receiving Pediatric Home Care Services (Medicare-Eligible Members Excluded)

Calendar Year of Service	Hospital Claims Expense Paid	Total Bed Days	Cost Per User Per Day	Mean Annual Treatment Days Per User
2013	$ 20,085,822	6,666	$ 3,013	21
2014	$ 22,113,097	7,576	$ 2,919	23
2015	$ 23,087,362	7,671	$ 3,010	23

Based on the International Classification of Diseases Version 10 (ICD-10),[29] BerryDunn grouped each admission into the Major Diagnostic Category (MDC)[30] assigned to its Centers for Medicare and Medicaid Services (CMS) Medicare Severity Diagnosis-Related Group (MS-DRG).[31]

Table 6, on the following page, displays, by MDC, calendar 2015 hospitalization cost quantiles for CCMP members authorized for CSN services by increments of 5% up to 30%, reflecting the highest plausible potentially avoidable admissions expense, for Medicaid and commercial health insurance combined. Table 7 displays just Medicaid costs, and Table 8 displays just commercial insurance costs. The quantile tables provide a tool for estimating a range of avoidable hospitalization costs based on varying assumptions about the proportion of hospitalizations in each diagnostic category that are avoidable.

The likely costs of truly avoidable admissions are far to the left side of the tables. For example, referencing Table 6, if we assume that all categories have an avoidable rate of 10% of admissions, the maximum savings realizable is $2.3 million if the entire 10% were eliminated. After taking into account a more realistic assumption about the proportion of avoidable admissions actually achieved, and also taking into account the offsetting increase in other costs incurred when the patient is not in the inpatient unit, the savings would be significantly lower than $2.3 million. Applying the same assumptions to Medicaid spending in Table 7 (at 10% potentially avoidable) would result in savings of $1.3 million at most, and similarly 10% of the commercial inpatient admission costs is approximately $1 million.

It may be that the modest size of this potential savings reflects the degree to which existing spending on CSN services and other support services for the CCMP population is preventing hospitalizations in this population.

Table 6: Selected Quantiles and Total Calendar 2015 Cost to Medicaid and Commercial Payers of Hospitalization of CCMP Members Receiving Pediatric Home Care Services by Major Diagnostic Category (Medicare-Eligible Members Excluded)

Major Diagnostic Category (MDC)	5% of Expense	10% of Expense	15% of Expense	20% of Expense	25% of Expense	30% of Expense	Total Expense
Diseases & Disorders of the Respiratory System	$ 384,048	$ 768,095	$1,152,143	$1,536,191	$1,920,239	$2,304,286	$ 7,680,955
Diseases & Disorders of the Circulatory System	$ 153,706	$ 307,413	$ 461,119	$ 614,825	$ 768,532	$ 922,238	$ 3,074,126
Infectious & Parasitic Diseases, Systemic or Unspecified Sites	$ 125,861	$ 251,723	$ 377,584	$ 503,445	$ 629,307	$ 755,168	$ 2,517,227
Diseases and Disorders of the Nervous System	$ 105,791	$ 211,582	$ 317,373	$ 423,165	$ 528,956	$ 634,747	$ 2,115,823
Diseases & Disorders of the Digestive System	$ 91,343	$ 182,686	$ 274,029	$ 365,372	$ 456,715	$ 548,058	$ 1,826,860
Diseases & Disorders of the Musculoskeletal System & Connective Tissue	$ 81,853	$ 163,707	$ 245,560	$ 327,413	$ 409,266	$ 491,120	$ 1,637,065
Diseases & Disorders of the Ear, Nose, Mouth & Throat	$ 58,491	$ 116,981	$ 175,472	$ 233,963	$ 292,453	$ 350,944	$ 1,169,813
Endocrine, Nutritional & Metabolic Diseases & Disorders	$ 53,936	$ 107,873	$ 161,809	$ 215,745	$ 269,682	$ 323,618	$ 1,078,726
Factors Influencing Health Status & Other Contacts with Health Services	$ 27,200	$ 54,400	$ 81,601	$ 108,801	$ 136,001	$ 163,201	$ 544,005
Diseases & Disorders of the Hepatobiliary System & Pancreas	$ 19,515	$ 39,030	$ 58,545	$ 78,061	$ 97,576	$ 117,091	$ 390,303
Diseases & Disorders of the Skin, Subcutaneous Tissue & Breast	$ 13,855	$ 27,710	$ 41,564	$ 55,419	$ 69,274	$ 83,129	$ 277,096
Diseases & Disorders of the Kidney & Urinary Tract	$ 12,782	$ 25,565	$ 38,347	$ 51,129	$ 63,911	$ 76,694	$ 255,645
Other Major Diagnostic Categories	$ 25,986	$ 51,972	$ 77,958	$ 103,944	$ 129,930	$ 155,916	$ 519,720
Grand Total	$1,154,368	$2,308,736	$3,463,104	$4,617,472	$5,771,841	$6,926,209	$23,087,362

Table 7: Selected Quantiles and Total Calendar 2015 Cost to Medicaid of Hospitalization of CCMP Members Receiving Pediatric Home Care Services by Major Diagnostic Category (Medicare-Eligible Members Excluded)

Major Diagnostic Category (MDC)	5% of Expense	10% of Expense	15% of Expense	20% of Expense	25% of Expense	30% of Expense	Total Expense
Diseases & Disorders of the Respiratory System	$ 207,666	$ 415,332	$ 622,997	$ 830,663	$1,038,329	$1,245,995	$ 4,153,315
Diseases & Disorders of the Circulatory System	$ 87,171	$ 174,343	$ 261,514	$ 348,686	$ 435,857	$ 523,029	$ 1,743,429
Infectious & Parasitic Diseases, Systemic or Unspecified Sites	$ 72,411	$ 144,823	$ 217,234	$ 289,645	$ 362,056	$ 434,468	$ 1,448,226
Diseases and Disorders of the Nervous System	$ 64,650	$ 129,300	$ 193,951	$ 258,601	$ 323,251	$ 387,901	$ 1,293,003
Diseases & Disorders of the Digestive System	$ 42,811	$ 85,623	$ 128,434	$ 171,246	$ 214,057	$ 256,869	$ 856,228
Diseases & Disorders of the Musculoskeletal System & Connective Tissue	$ 38,335	$ 76,670	$ 115,005	$ 153,340	$ 191,675	$ 230,010	$ 766,701
Diseases & Disorders of the Ear, Nose, Mouth & Throat	$ 33,905	$ 67,810	$ 101,715	$ 135,620	$ 169,525	$ 203,430	$ 678,102
Endocrine, Nutritional & Metabolic Diseases & Disorders	$ 29,759	$ 59,518	$ 89,278	$ 119,037	$ 148,796	$ 178,555	$ 595,184
Diseases & Disorders of the Hepatobiliary System & Pancreas	$ 17,530	$ 35,060	$ 52,590	$ 70,120	$ 87,651	$ 105,181	$ 350,602
Factors Influencing Health Status & Other Contacts with Health Services	$ 14,969	$ 29,938	$ 44,908	$ 59,877	$ 74,846	$ 89,815	$ 299,384
Other Major Diagnostic Categories	$ 37,610	$ 75,221	$ 112,831	$ 150,442	$ 188,052	$ 225,663	$ 752,210
Grand Total	$ 646,819	$1,293,638	$1,940,458	$2,587,277	$3,234,096	$3,880,915	$12,936,385

Table 8: Selected Quantiles and Total Calendar 2015 Cost to Commercial Payers of Hospitalization of CCMP Members Receiving Pediatric Home Care Services by Major Diagnostic Category (Medicare-Eligible Members Excluded)

Major Diagnostic Category (MDC)	5% of Expense	10% of Expense	15% of Expense	20% of Expense	25% of Expense	30% of Expense	Total Expense
Diseases & Disorders of the Respiratory System	$ 176,382	$ 352,764	$ 529,146	$ 705,528	$ 881,910	$1,058,292	$ 3,527,639
Diseases & Disorders of the Circulatory System	$ 66,535	$ 133,070	$ 199,605	$ 266,139	$ 332,674	$ 399,209	$ 1,330,697
Infectious & Parasitic Diseases, Systemic or Unspecified Sites	$ 53,450	$ 106,900	$ 160,350	$ 213,800	$ 267,250	$ 320,700	$ 1,069,001
Diseases & Disorders of the Digestive System	$ 48,532	$ 97,063	$ 145,595	$ 194,126	$ 242,658	$ 291,189	$ 970,631
Diseases & Disorders of the Musculoskeletal System & Connective Tissue	$ 43,518	$ 87,036	$ 130,555	$ 174,073	$ 217,591	$ 261,109	$ 870,364
Diseases and Disorders of the Nervous System	$ 41,141	$ 82,282	$ 123,423	$ 164,564	$ 205,705	$ 246,846	$ 822,819
Diseases & Disorders of the Ear, Nose, Mouth & Throat	$ 24,586	$ 49,171	$ 73,757	$ 98,342	$ 122,928	$ 147,513	$ 491,711
Endocrine, Nutritional & Metabolic Diseases & Disorders	$ 24,177	$ 48,354	$ 72,531	$ 96,708	$ 120,885	$ 145,063	$ 483,542
Other Major Diagnostic Categories	$ 29,229	$ 58,457	$ 87,686	$ 116,914	$ 146,143	$ 175,372	$ 584,572
Grand Total	$ 507,549	$1,015,098	$1,522,647	$2,030,196	$2,537,744	$3,045,293	$10,150,978

2.4.2 Costs of CSN Services

In this section, costs of CSN services are presented for comparison to the potentially avoidable hospitalization costs from sub-section 2.4.1. Table 9, below, summarizes hours of CSN care, overall and per user, authorized by MassHealth and Table 10 summarizes services provided by MassHealth-contracted home nursing agencies and independent nurses over the period 2013 to 2015.[x] Authorized hours per user increase year to year, while utilized hours per user are decreasing year to year, leading to a significant decrease in the ratio of utilized to authorized hours of service from 78% to 73% over the time period, as shown on the following page in Table 11.[xi] The following measures include all authorized CSN hours, including hours authorized for periods when the members were hospitalized.

Table 9: MassHealth Continuous Skilled Nursing Hours Authorized Per User Per Year for CCMP Members (Procedure Codes T1002 & T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	Hours of CSN Service Authorized	Unique Users Authorized	Hours Authorized Per User Per Year	Change in Hours Per User Per Year
2013	1,862,246	633	2,942	
2014	2,082,788	691	3,014	2%
2015	2,158,176	699	3,088	2%

Table 10: MassHealth Continuous Skilled Nursing Hours Utilized Per User Per Year for CCMP Members (Procedure Codes T1002 & T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	Hours of CSN Service Utilized	Unique Service Users	Hours Utilized Per User Per Year	Change in Hours Per User Per Year
2013	1,459,124	615	2,373	
2014	1,576,570	673	2,343	-1%
2015	1,573,844	686	2,294	-2%

[x] Throughout this report, BerryDunn calculates authorized units per year by allocating authorized units evenly by day to the entire time span of each authorization, then summarizes these allocated authorized units by year.

[xixi] The tables above (and the chart below) include hours authorized for days when the CSN members were hospitalized or in other facility-based care (e.g., skilled nursing facility or facility-based hospice care). Clearly, CSN hours for days when the patient is not at home cannot be filled. BerryDunn analyzed this effect by re-calculating the utilized and authorized CSN hours while excluding CSN hours authorized (or paid, if any) on days on which a member was in facility care. This raised the utilized to authorized ratio by 2% in each year; the overall magnitudes of authorized, paid, and unfilled hours were similar, and the rate of decrease in the utilization to authorization ratio over time was unchanged.

Table 11: Ratio of MassHealth Continuous Skilled Nursing Hours Authorized Per User Per Year to Hours Utilized Per User Per Year (Procedure Codes T1002 & T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	Hours Utilized Per User Per Year	Hours Authorized Per User Per Year	Hours Utilized to Authorized Ratio	Change in Utilized to Authorized Ratio
2013	2,373	2,942	78%	
2014	2,343	3,014	76%	-3%
2015	2,294	3,088	73%	-4%

Total MassHealth costs for CSN services, displayed below in Table 12, are about three times higher annually than hospitalization costs; as noted above about twice as many members receive CSN services than are hospitalized in a given year.

Table 12: Annual Medicaid Expenses for CSN Services for CCMP Pediatric Home Care Patients (Procedure Codes T1002 & T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	Unique Users	CSN Claims Expense Paid	Annual Cost Per User
2013	615	$ 62,630,022	$ 101,837
2014	673	$ 67,762,298	$ 100,687
2015	686	$ 67,668,317	$ 98,642

However, the average cost per service user per day of service is nearly seven times higher for hospitalizations as for CSN services, as shown below in the fourth column of Table 13 on the following page. In addition, on average, CCMP members receiving CSN services paid for by Medicaid receive services on over 200 days each year at current levels of utilization and spending, as shown in the rightmost column of Table 13. This compares to mean annual hospitalization days per hospitalized member of approximately 23.

Table 13: Annual Medicaid Claim Expenses Per User Per Treatment Day for CSN Services for CCMP Pediatric Home Care Patients (Procedure Codes T1002 and T1003, Medicare-Eligible Members Excluded)

Calendar Year of Service	CSN Claims Expense Paid	Total Treatment Days	Cost Per User Per Day	Mean Annual Treatment Days Per User
2013	$ 62,260,018	135,566	$ 459	223
2014	$ 67,307,071	148,831	$ 452	223
2015	$ 67,286,325	149,991	$ 449	221

Because the CCMP population is at risk for institutionalization, and most would be institutionalized without CCMP, this CSN spending is in part responsible for avoiding costs of institutional care. The availability and use of CSN services is of course also relevant to the rate of potentially avoidable admissions in the CCMP population. This relationship has not been investigated directly, but as discussed above, home services more generally have been demonstrated to lead to small but significant decreases in potentially avoidable admissions in the CMC population, a relationship that might be stronger for CSN services in the CCMP population specifically under study in this report.

2.5 Authorized Home Care Hours Compared to Utilized Home Care Hours

As part of the research for this study, the Massachusetts Pediatric Home Nursing Campaign and the Home Care Alliance of Massachusetts, Inc. were asked to provide input on the topic of pediatric home care in Massachusetts. Representatives from these groups indicated that MassHealth-authorized home care hours often went unutilized as a result of a lack of home health providers to meet the demand for these services.

In a recent article in Hospital Pediatrics, 51 stakeholders known for CMC expertise were interviewed.[34] Stakeholders were from five metropolitan areas and consisted of interdisciplinary providers (inpatient and/or outpatient clinicians, home health providers, foster care affiliates, or policy professionals) and parents of CMC.[35] All stakeholders agreed that homelike settings are the ideal care sites for CMC, although all stakeholders reported prolonged hospitalizations for CMC in their regions.[36] The perceived causes of excess hospital days included:

1. Inadequate communication and coordination within health care teams and between clinicians and families
2. Widespread gaps in qualified pediatric home health services and DME providers
3. Inconsistent parent support
4. Policies that limit pediatric service eligibility, state-supported case management, and nonhospital care sites[37]

Solutions from the qualitative analysis of the interviews included expanded access to home nursing, robust care coordination, and family and clinician support to reduce hospital stays for the CMC population.[38] [xii]

Utilization of CSN services is unevenly distributed across the CCMP population. For example, the 68 members (one tenth of the members receiving service) in the bottom (lowest utilization) decile of the distribution received, on average, three hours per week of CSN services—which is 0.6% of the total CSN hours utilized across the population. Members in the second decile received about 11 hours per week on average, or 2.5% of the total utilized CSN hours; and the 68 members in the top decile (highest utilization) received an average of 111 hours per week (or about 16 hours per day), or 25% of the total CSN hours.

MassHealth requires prior authorization of CSN services in order to reimburse claims for CSN services. The amount of CSN services authorized per member and the proportion of authorized services utilized per member vary widely across the CCMP population. CCMP Members in the bottom utilization to authorization decile utilized on average only 15% of their authorized hours, and had an average of 38 hours of service authorized per week, implying an average utilization of 6 hours of service per week for these members. Members in the top utilization to authorization decile, on the other hand, were authorized for, and received, an average of 65 hours of service per week, for an average utilization to authorization ratio of 100%.

Generally, children with greater authorized hours have a higher proportion of their authorized hours filled, although there is significant variation in filled to authorized hours ratios in each decile. There were twelve members with authorized CSN services in 2015 who received no services; it is beyond the scope of this analysis to identify the reasons for this but it is not necessarily indicative of a problem, for example, if a patient died, moved, could not be kept at home, or otherwise left the program. Likewise, some members with very low hours authorized and/or very low utilization to authorization ratios may have experienced a change in condition preventing them from being treated at home, thus making them unavailable to receive CSN services.

While we are unable to draw conclusions about these patterns of authorization and service use, understanding large differences between authorized and delivered services would be important to understanding the potential to reduce avoidable admissions. It appears that the concerns of patient advocates about lack of access to service may be occurring in that segment of the CCMP population receiving relatively few weekly hours of authorized service.

[xii] Examining the distribution of CSN services in the Massachusetts CCMP population may be a starting point in understanding whether there is potential for improvement in Massachusetts.

3.0 Conclusion

Total Medicaid and MassHealth spending in the CCMP population for CSN services, at about $67 million in 2015, is almost three times higher than total spending for inpatient services, at $23 million. Because rates of avoidable ambulatory sensitive admissions and avoidable readmissions tend to be lower in the more complex CMC population than in the general pediatric population, the proportion of potentially avoidable admissions is unlikely to be as high as 20%, and is more likely to be below 10% (possibly well below). At 10%, if all potentially avoidable admissions could, in fact, be avoided, and if there were no offsetting costs for non-inpatient services, the result in 2015 would have been a modest savings of $2.3 million, $1.3 million of which would accrue to MassHealth. Because all CCMP children have such medical complexity that they would be at risk of institutionalization if they were not receiving CSN services at home, the current level of spending on CSN is almost certainly avoiding large expenditures for institutional care.

Appendix A

2017 Acts Chapter 47: An Act making appropriations for the fiscal year 2018 for the maintenance of the departments, boards, commissions, institutions and certain activities of the commonwealth, for interest, sinking fund and serial bond requirements and for certain permanent improvements

…

SECTION 132. The center for health information and analysis shall provide a report related to costs associated with the hospitalization of medically complex pediatric home care patients. The report shall include: (i) the number of medically complex pediatric home care patients, including those who have aged into adulthood, who are hospitalized annually and the length of their stay; (ii) the estimated cost to MassHealth of the annual hospitalization of medically complex pediatric home care patients; (iii) the estimated cost to private payers of the annual hospitalization of medically complex pediatric home care patients; and (iv) a cost analysis comparing continuous skilled nursing service costs to the cost of likely avoidable hospitalizations.

The center shall consult with the Massachusetts Pediatric Home Nursing Campaign and the Home Care Alliance of Massachusetts, Inc. and may consult with providers of continuous skilled nursing for children with complex medical needs. The report shall be made publicly available on the center's website and shall be filed with the clerks of the senate and house of representatives, the chairs of the joint committee on health care financing and the senate and house committees on ways and means on or before December 1, 2017.

4.0 Endnotes

Executive Summary Endnotes

[1] Cohen E, Berry JG, Camacho X, Anderson G, Wodchis W, Guttmann A. Patterns and costs of health care use of children with medical complexity. Pediatrics. 2012 Dec;130(6):e1463–70. Accessed: Accessed 4 May 2018. Accessed 4 May 2018: https://www.ncbi.nlm.nih.gov/pubmed/23184117.

[2] Coller R, Nelson B, Sklansky D, et.al. Preventing Hospitalizations in Children with Medical Complexity: A Systematic Review. Pediatrics. November 2014. Accessed 26 February 2018: http://pediatrics.aappublications.org/content/early/2014/11/05/peds.2014-1956.

Report Body Endnotes

[1] Cohen E, Berry JG, Camacho X, Anderson G, Wodchis W, Guttmann A. Patterns and costs of health care use of children with medical complexity. Pediatrics. 2012 Dec;130(6):e1463–70. Accessed: Accessed 4 May 2018. Accessed 4 May 2018: https://www.ncbi.nlm.nih.gov/pubmed/23184117.

[2] Coller R, Nelson B, Sklansky D, et.al. Preventing Hospitalizations in Children with Medical Complexity: A Systematic Review. Pediatrics. November 2014. Accessed 26 February 2018: http://pediatrics.aappublications.org/content/early/2014/11/05/peds.2014-1956.

[3] Cohen E, Kuo D, Agrawal R, et.al. Children With Medical Complexity: An Emerging Population for Clinical and Research Initiatives. Pediatrics. Mar 2011;127(3):529-538. Accessed 19 March 2018: http://pediatrics.aappublications.org/content/127/3/529.short.

[4] Berry JG, Agrawal, RK, Cohen E, Kuo DZ. The Landscape of Medical Care for Children with Medical Complexity. 4 March 2018: http://pediatrics.aappublications.org/content/127/3/529.short.

[5] An Act Making Appropriations for the Fiscal Year 2018 for the Maintenance of the Departments, Boards, Commissions, Institutions and Certain Activities of the Commonwealth, for Interest, Sinking Fund and Serial Bond Requirements and for Certain Permanent Improvements, 2017 Mass. Acts, Chapter 47.

[6] Massachusetts Center for Health Information and Analysis. Massachusetts All Payer Claims Database. Accessed 3 May 2018: http://www.chiamass.gov/ma-apcd/.

[7] An Act Making Appropriations for the Fiscal Year 2018 for the Maintenance of the Departments, Boards, Commissions, Institutions and Certain Activities of the Commonwealth, for Interest, Sinking Fund and Serial Bond Requirements and for Certain Permanent Improvements, 2017 Mass. Acts, Chapter 47.

[8] An Act Making Appropriations for the Fiscal Year 2018 for the Maintenance of the Departments, Boards, Commissions, Institutions and Certain Activities of the Commonwealth, for Interest, Sinking Fund and Serial Bond Requirements and for Certain Permanent Improvements, 2017 Mass. Acts, Chapter 47.

[9] *Op. Cit.* Coller R, Nelson B, Sklansky D, et.al.

[10] *Op. Cit*. Coller R, Nelson B, Sklansky D, et.al.

[11] *Op. Cit*. Coller R, Nelson B, Sklansky D, et.al.

[12] *Op. Cit*. Coller R, Nelson B, Sklansky D, et.al.

[13] Accessed 15 March 2018: https://www.ahrq.gov/research/findings/nhqrdr/chartbooks/carecoordination/measure3.html.

[14] *Op. cit.* Coller R, Nelson B, Sklansky D, et.al.

[15] Berry J, Hall D, Kuo D, et.al. Hospital utilization and characteristics of patients experiencing recurrent readmission within children's hospitals. JAMA. 2011 Feb 16;305(7):682-90. Accessed 16 March 2016: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3118568/.

[16] Lu, S., & Kuo, D. Z. (2012). Hospital Charges of Potentially Preventable Pediatric Hospitalizations. Academic Pediatrics, 12(5), 436–444. Accessed 19 March 2018: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4140212/.

[17]Op. Cit. Berry J, Hall D, Kuo D, et.al.

[18] *Op. Cit.* Lu S and Kue D.

[19] *Op. Cit.* Coller R, Nelson B, Sklansky D, et.al.

[20] Armour BS, Ouyang L, Thibadeau J, et. al. Hospitalization for urinary tract infections and the quality of preventive health care received by people with spina bifida. Disabil Health J. 2009 Jul;2(3):145-52. Accessed 29 March 2018: https://www.ncbi.nlm.nih.gov/pubmed/21122753.

[21] *Op. Cit*. Coller R, Nelson B, Sklansky D, et.al.

[22] *Op. Cit.* Berry J, Hall D, Kuo D, et. al.

[23] Hain, PD, Gay JC, Berutti TW, et. al. Preventability of Early Readmissions at a Children's Hospital. Pediatrics 2013 Jan;131(1). Accessed 11 April 2018: http://pediatrics.aappublications.org/content/131/1/e171

[24] Gay JC, Thurm CW, Hall M, et. al. Home Health Nursing Care and Hospital Use for Medically Complex Children. Pediatrics 2016 Nov 138(5). Accessed 3 May 2018: http://pediatrics.aappublications.org/content/early/2016/10/24/peds.2016-0530.

[25] *Op. Cit.* Gay JC, Thurm CW, Hall M.

[26] *Op. Cit.* Gay JC, Thurm CW, Hall M.

[27] *Op. Cit*. Coller R, Nelson B, Sklansky D, et.al.

[28] *Op. Cit.* Hain, PD, Gay JC, Berutti TW, et. al.

[29] World Health Organization. Classifications of Diseases (ICD). Accessed 4 May 2018: http://www.who.int/classifications/icd/en/.

[30] Centers for Medicare and Medicaid Services. Draft ICD-10-CM/PCS MS-DRGv28 Definitions Manual. Accessed 4 May 2018: https://www.cms.gov/icd10manual/fullcode_cms/P0001.html.

[31] Centers for Medicare and Medicaid Services. MS-DRG Classification and Software. Accessed 4 May 2018: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/MS-DRG-Classifications-and-Software.html.

[34] Boss RD, Williams, EP, Henderson CM. et. al. Pediatric Chronic Critical Illness: Reducing Excess Hospitalizations. Hospital Pediatrics 2017 Aug 7(9). Accessed 3 May 2018: http://hosppeds.aappublications.org/content/7/8/460.

[35] *Op.Cit.* Boss RD, Williams EP, Henderson CM, et. al.

[36] *Op.Cit.* Boss RD, Williams EP, Henderson CM, et. al.

[37] *Op.Cit.* Boss RD, Williams EP, Henderson CM, et. al.

[38] *Op.Cit.* Boss RD, Williams EP, Henderson CM, et. al.

Note: Footnote numbers 32 and 33 are intentionally omitted.